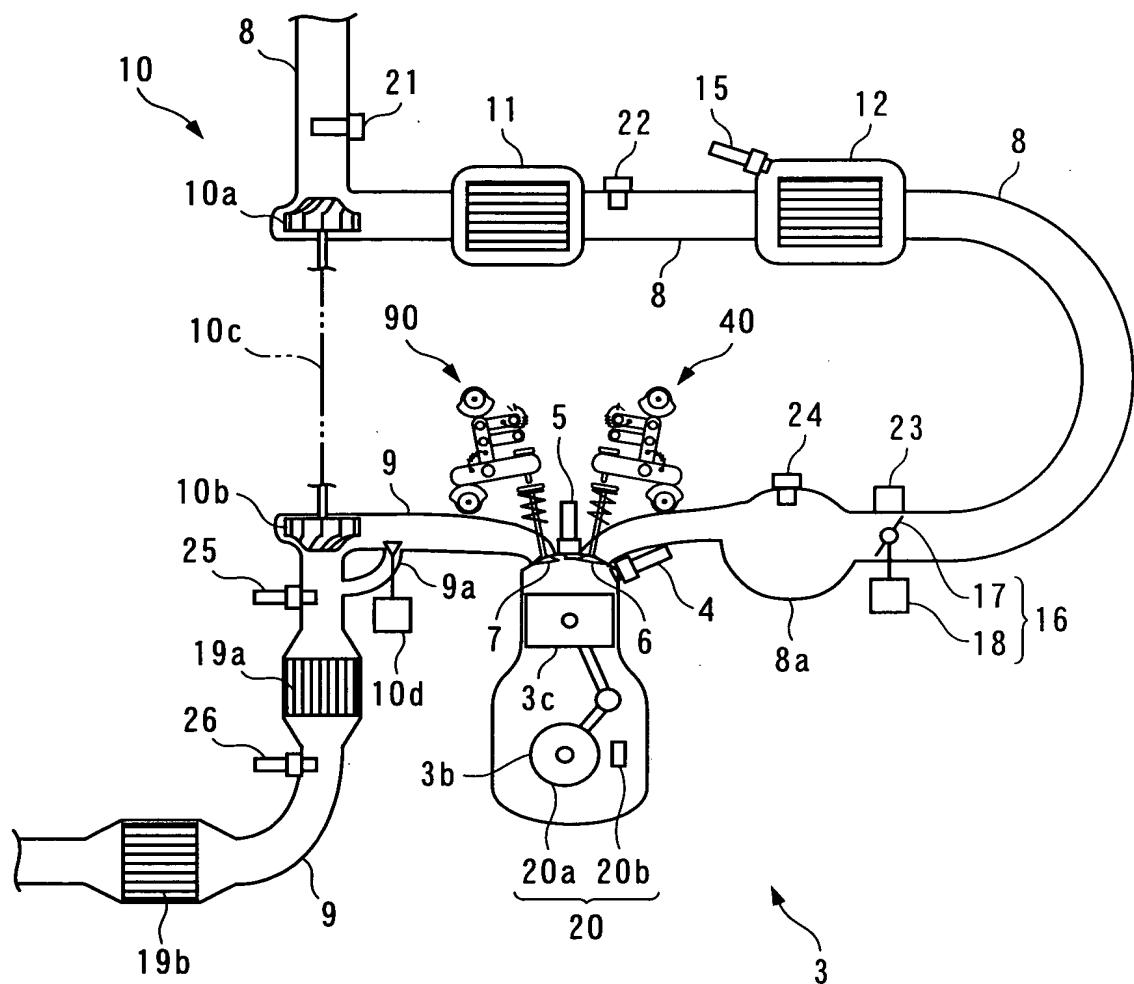


FIG. 1



BEST AVAILABLE COPY

FIG. 2

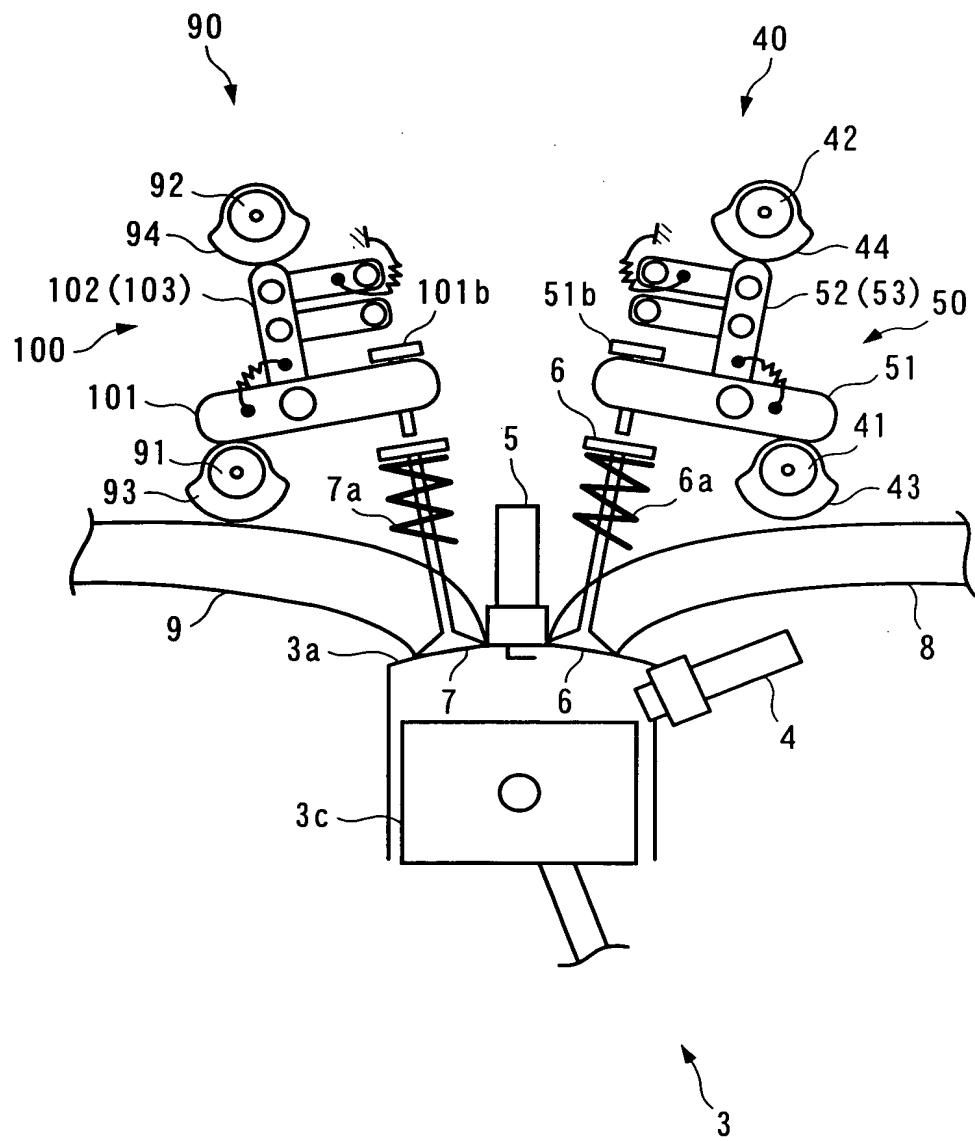
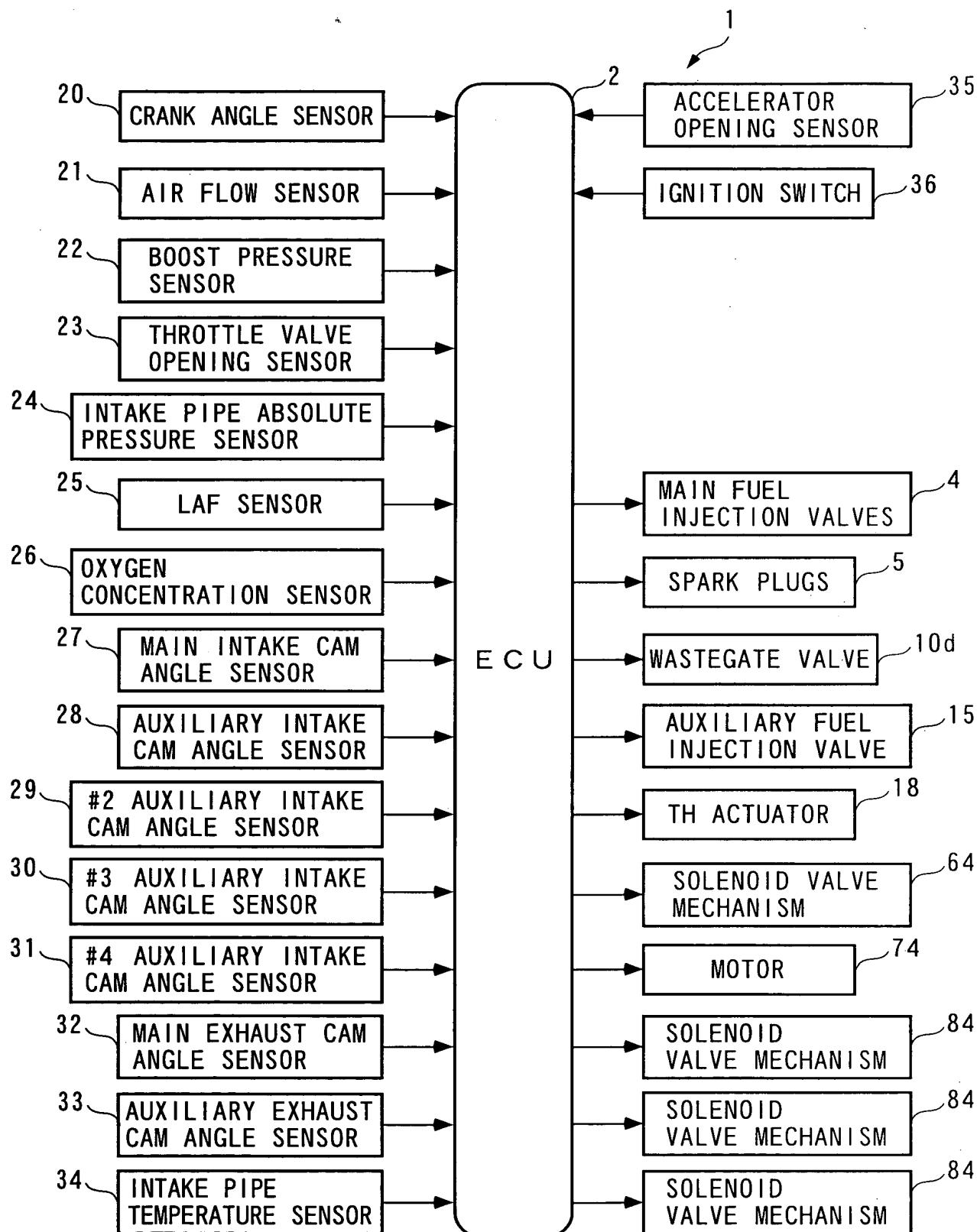


FIG. 3



H 0 3 - 1 2 6 6

Title: INTAKE AIR AMOUNT CONTROL
SYSTEM FOR INTERNAL COMBUSTION
ENGINE
Inventor: Yuji YASUI et al.
Appln. No.: New Application
Docket No.: 108419-00075

(4 / 5 4)

F I G. 4

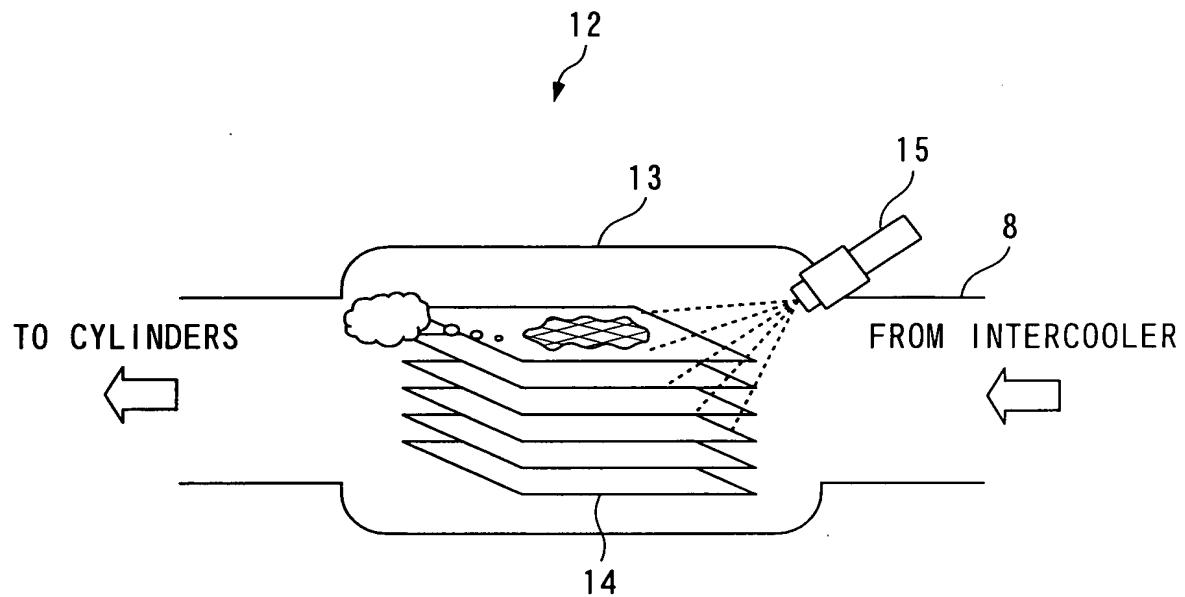
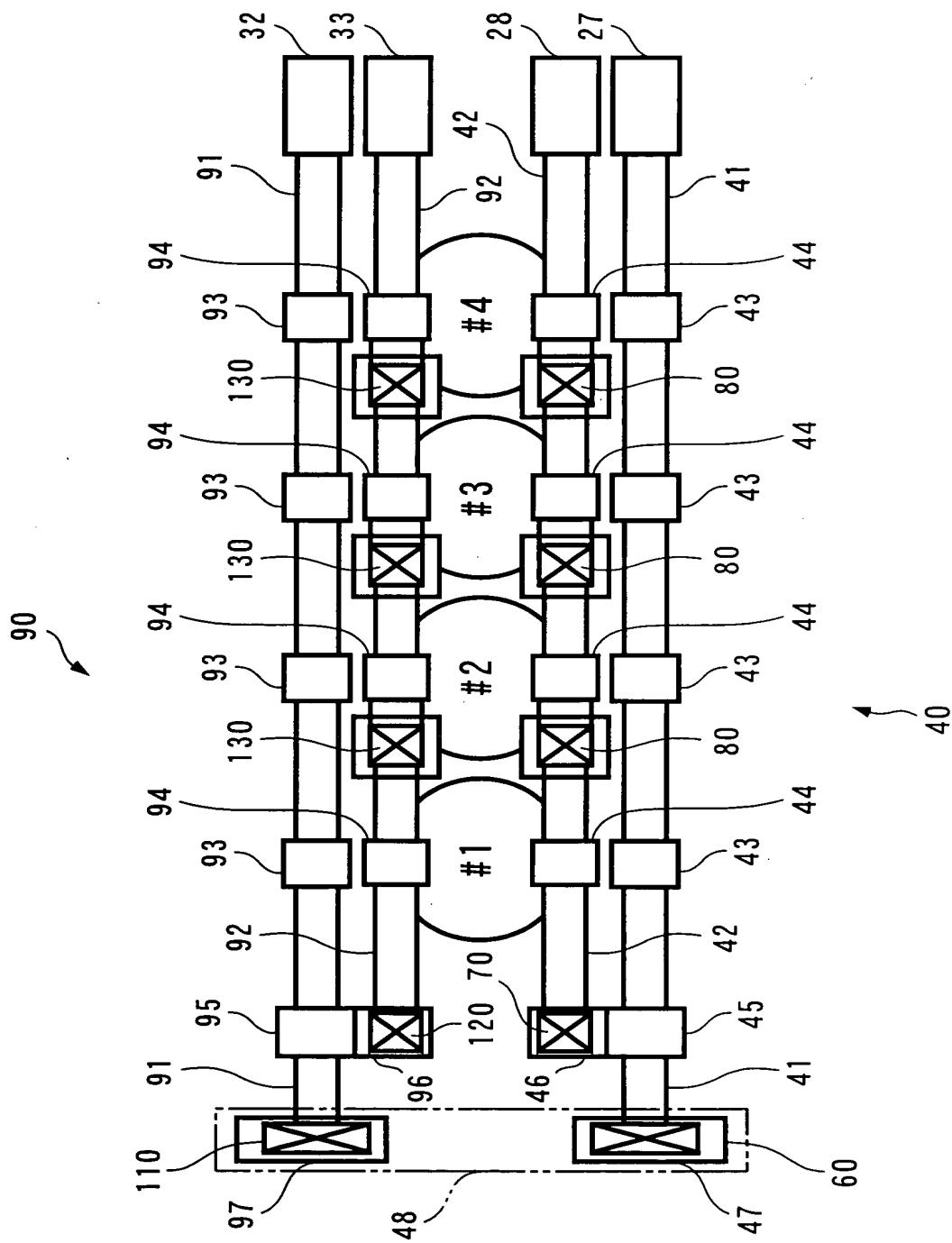
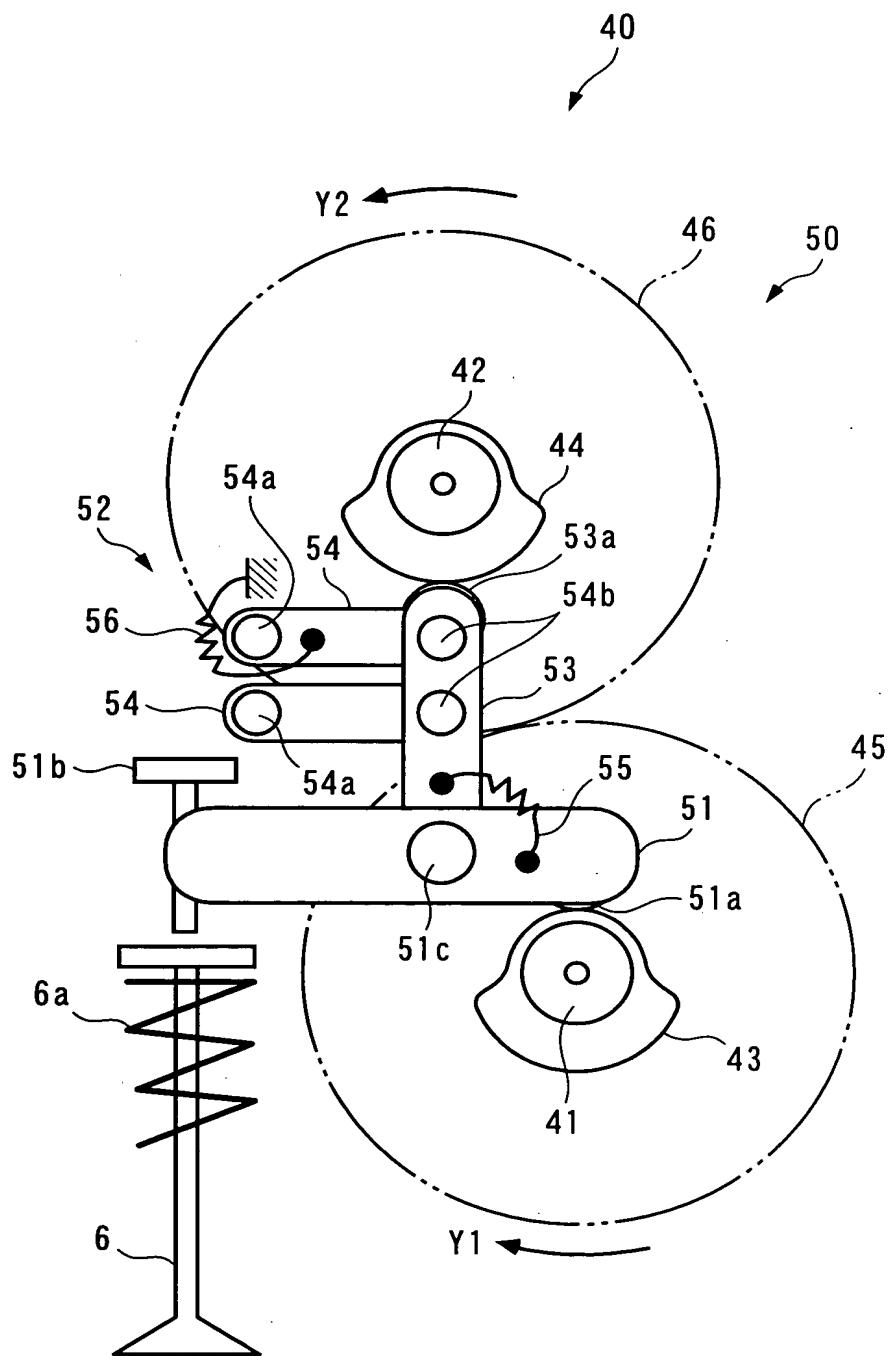


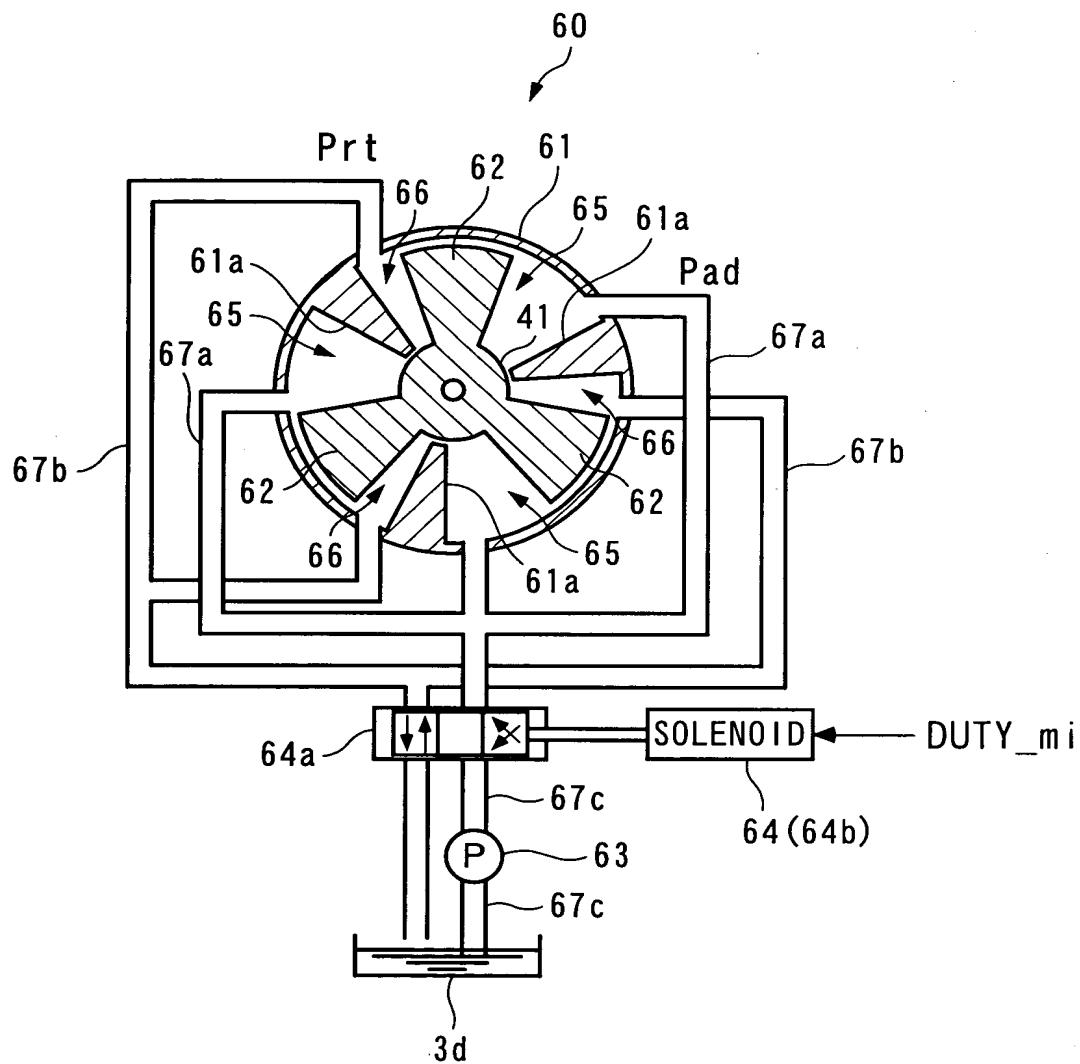
FIG. 5



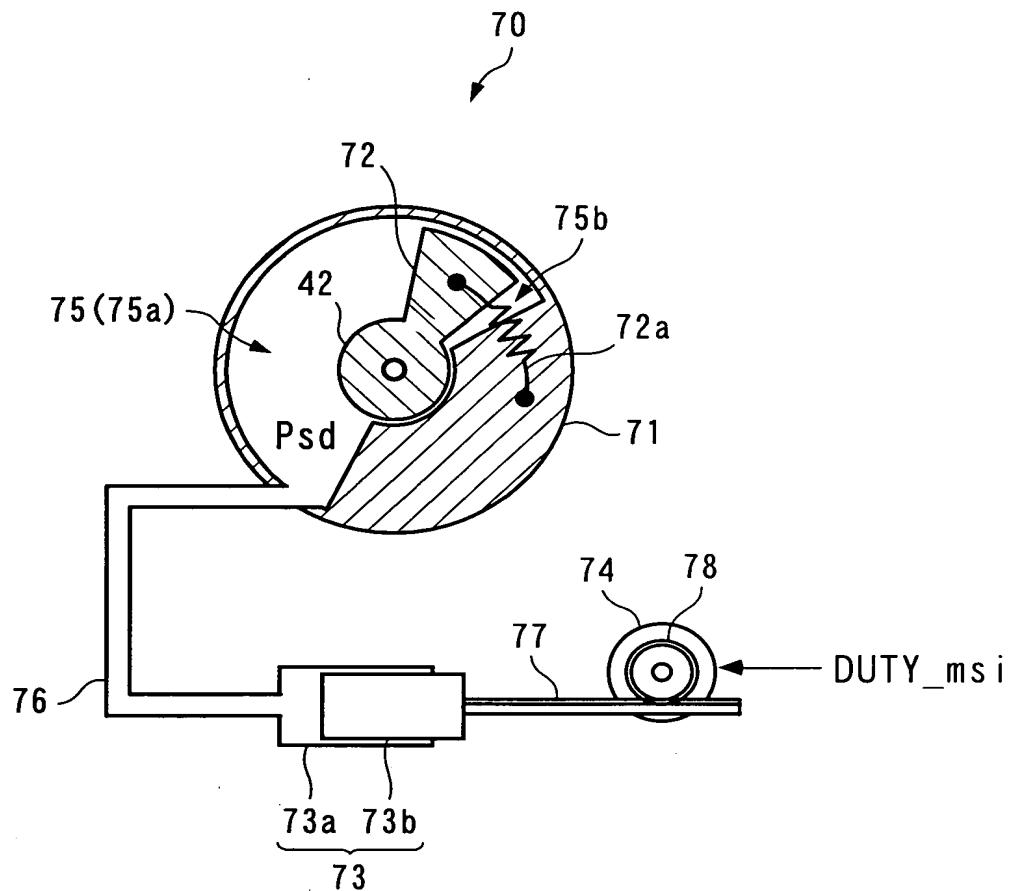
F I G. 6



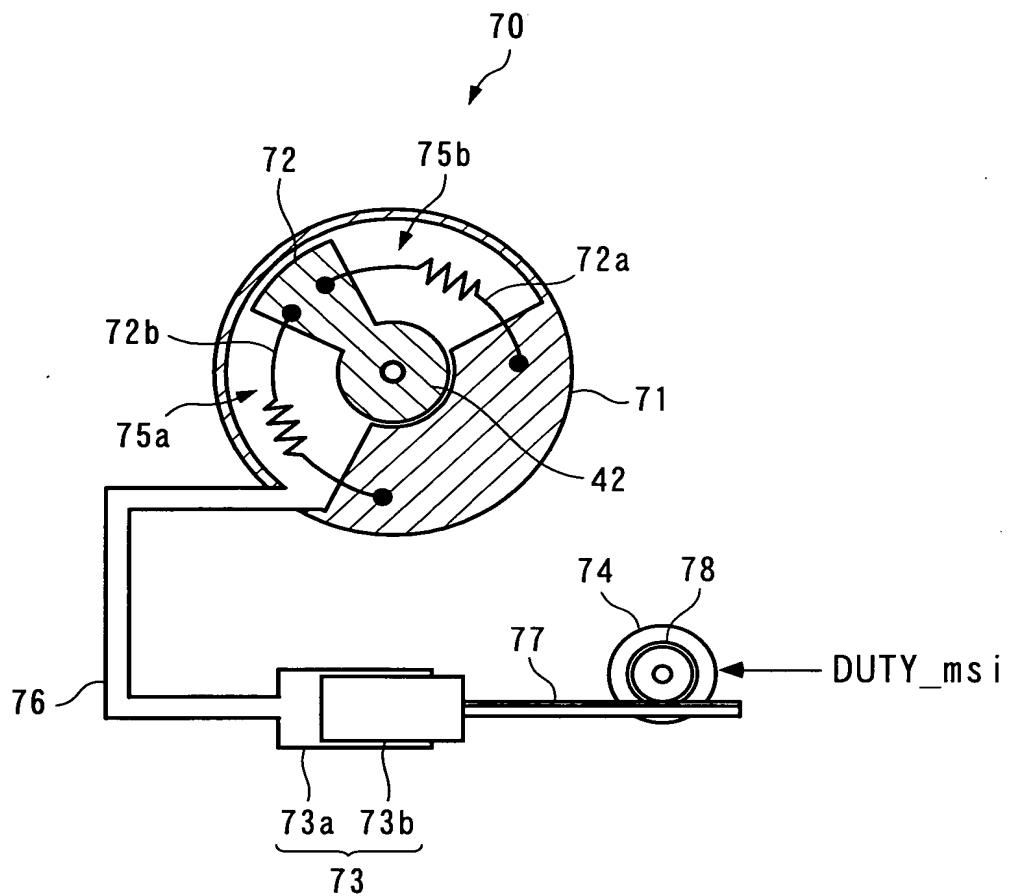
F I G. 7



F I G. 8



F I G . 9



F I G. 1 0

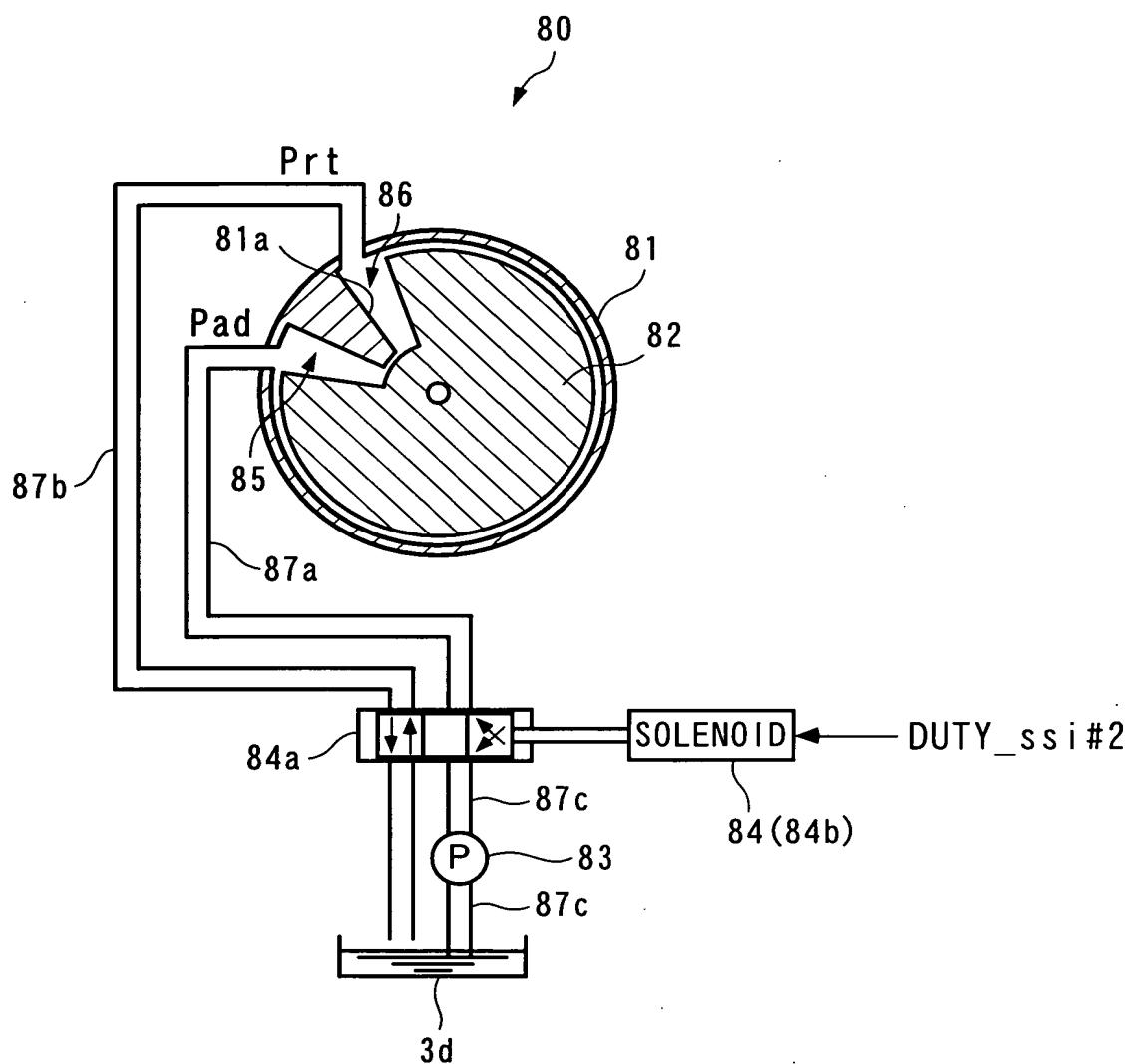
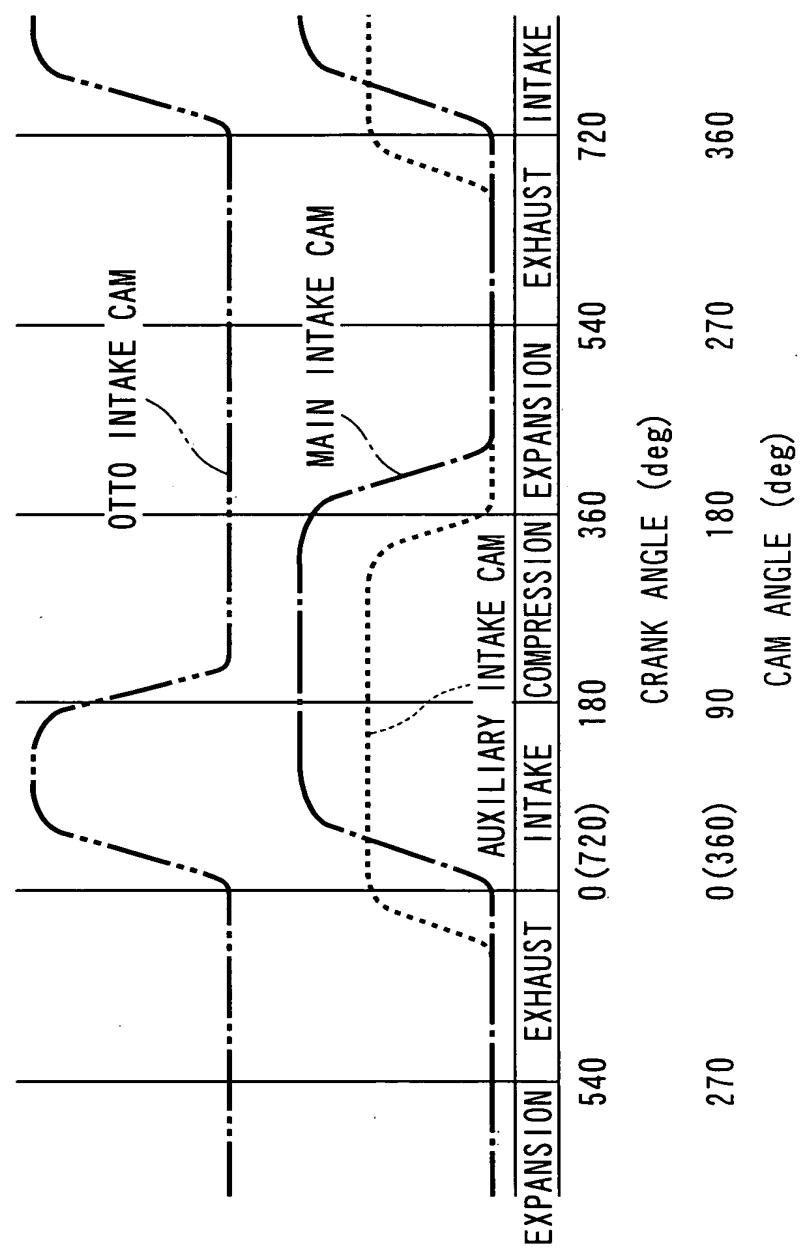
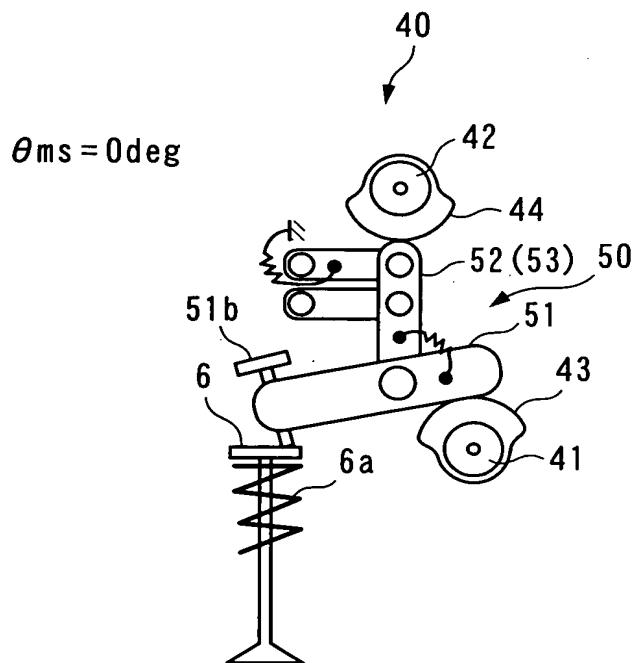


FIG. 11



F I G. 12 A



F I G. 12 B

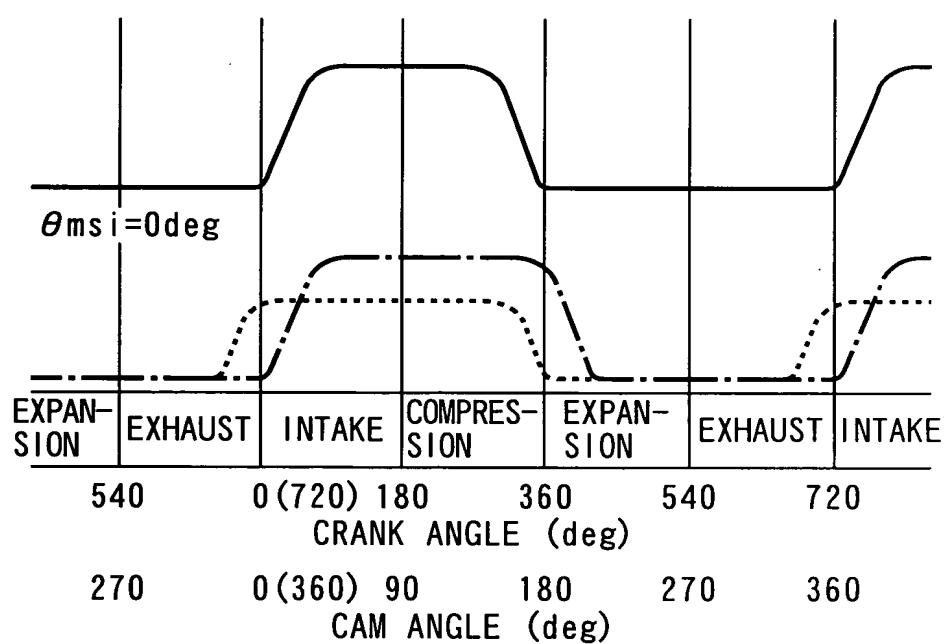


FIG. 13 A

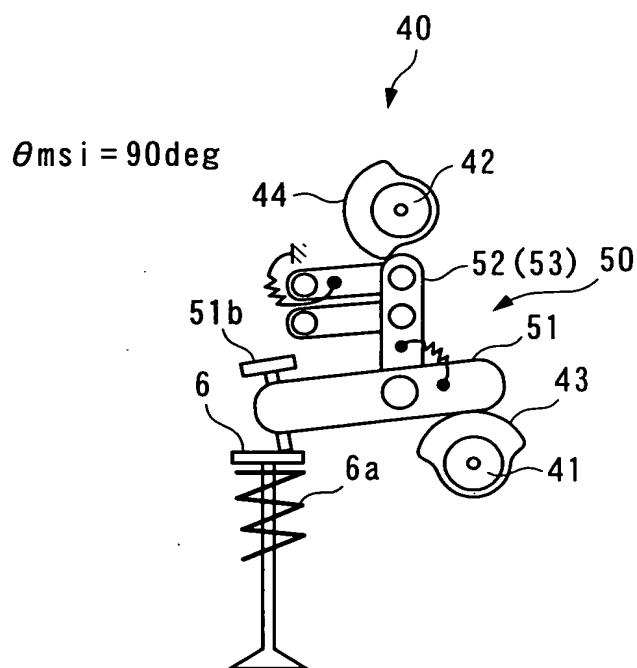


FIG. 13 B

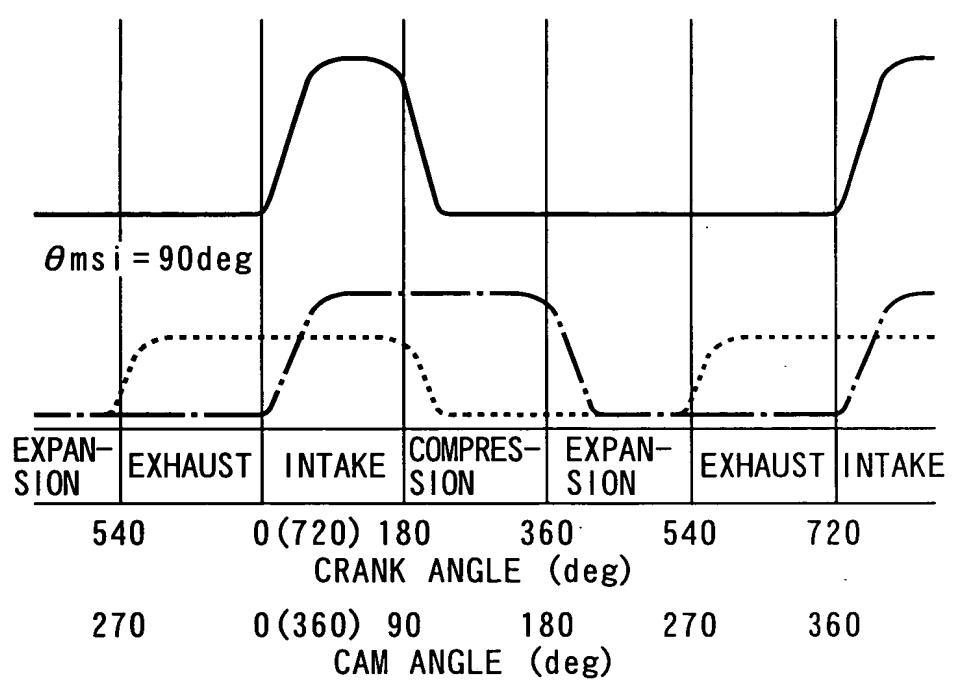


FIG. 14 A

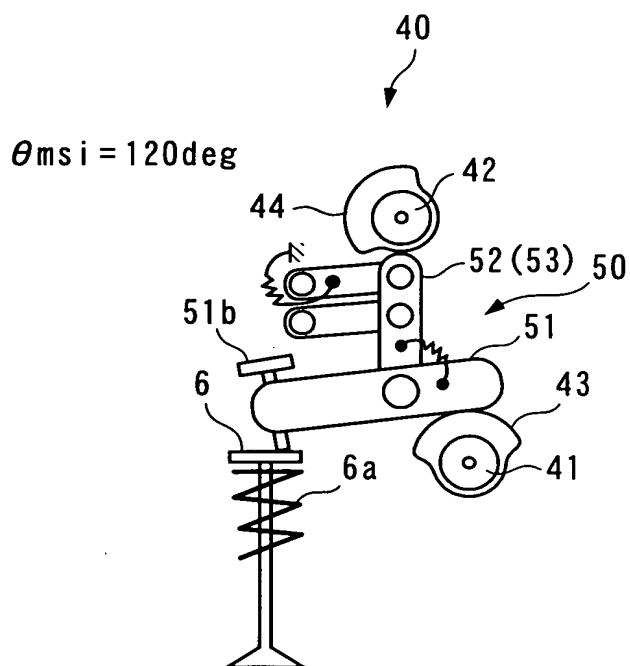
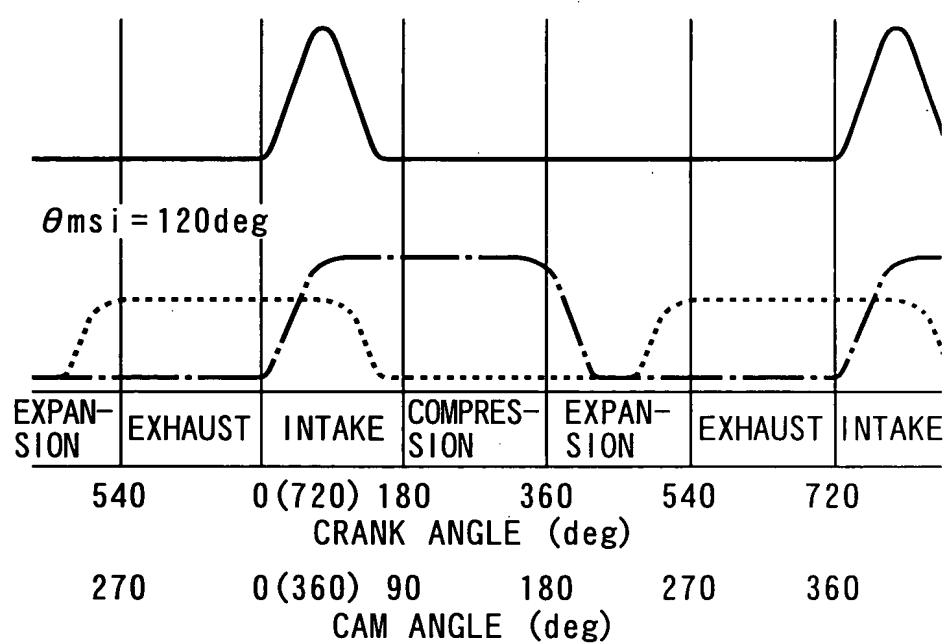
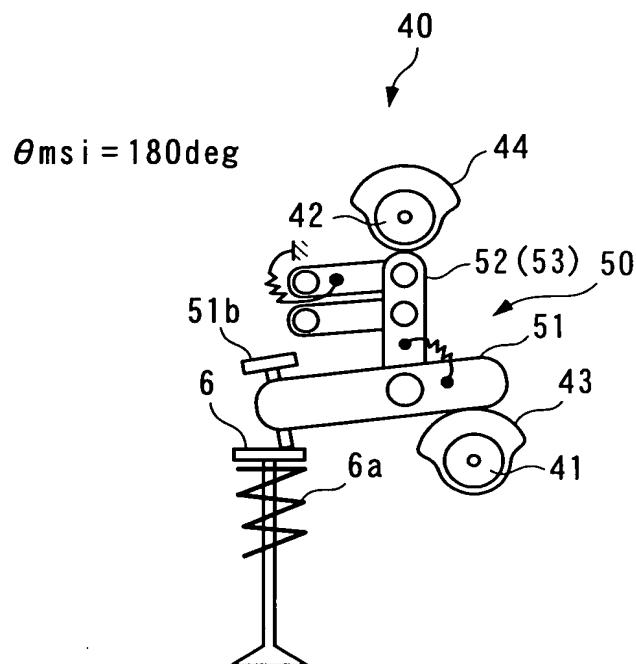


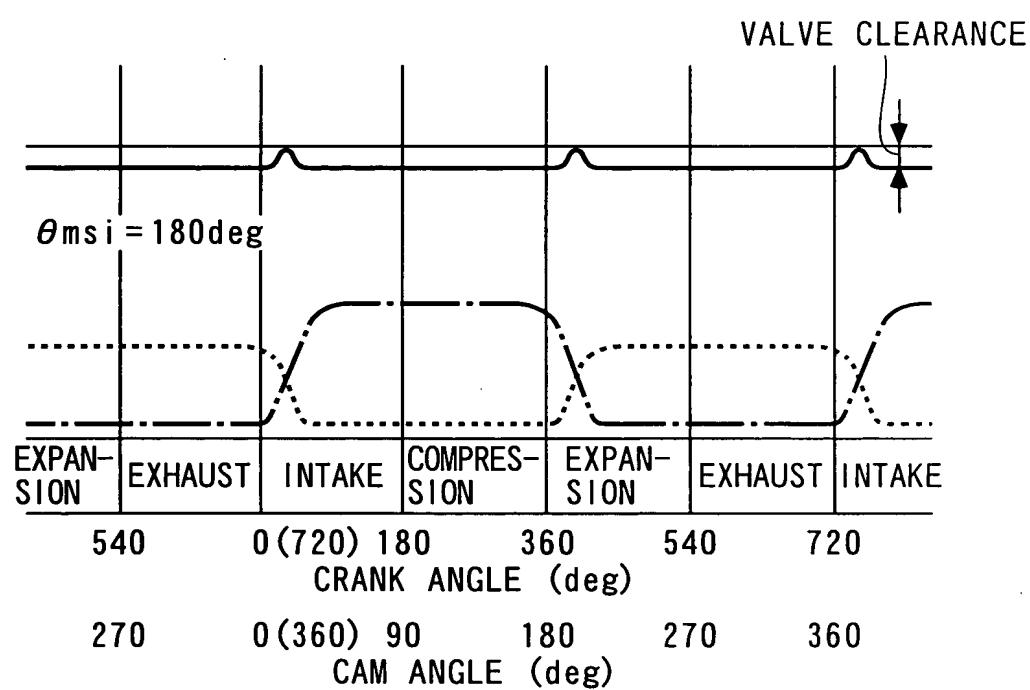
FIG. 14 B



F I G. 1 5 A



F I G. 1 5 B



F I G. 1 6

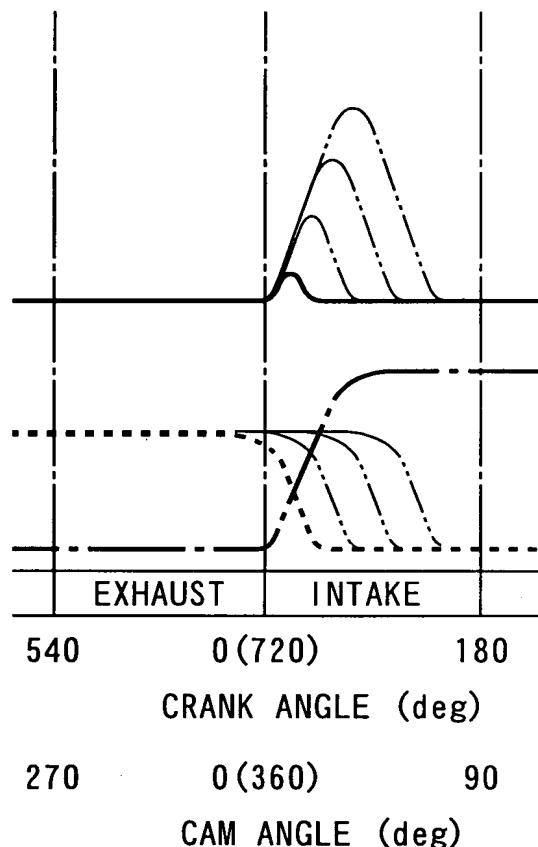


FIG. 17

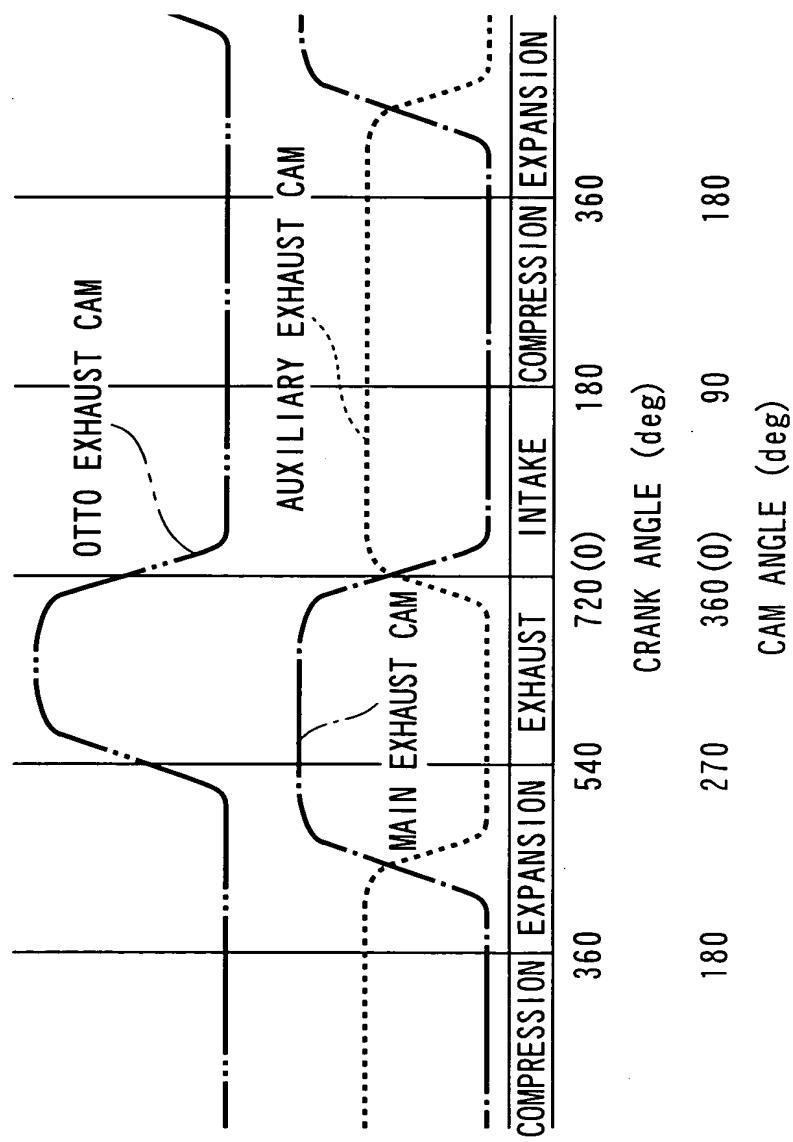


FIG. 18

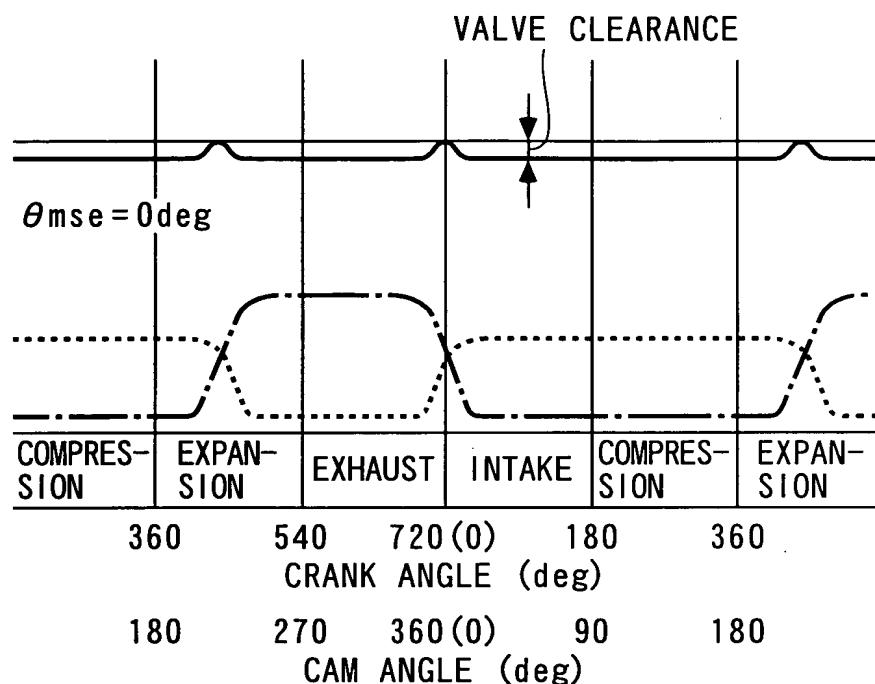


FIG. 19

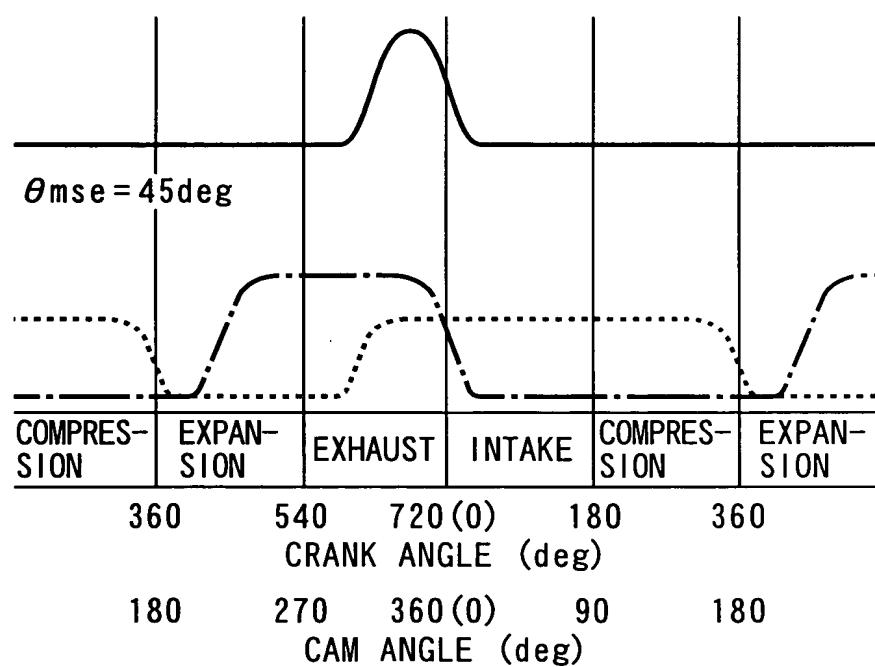


FIG. 20

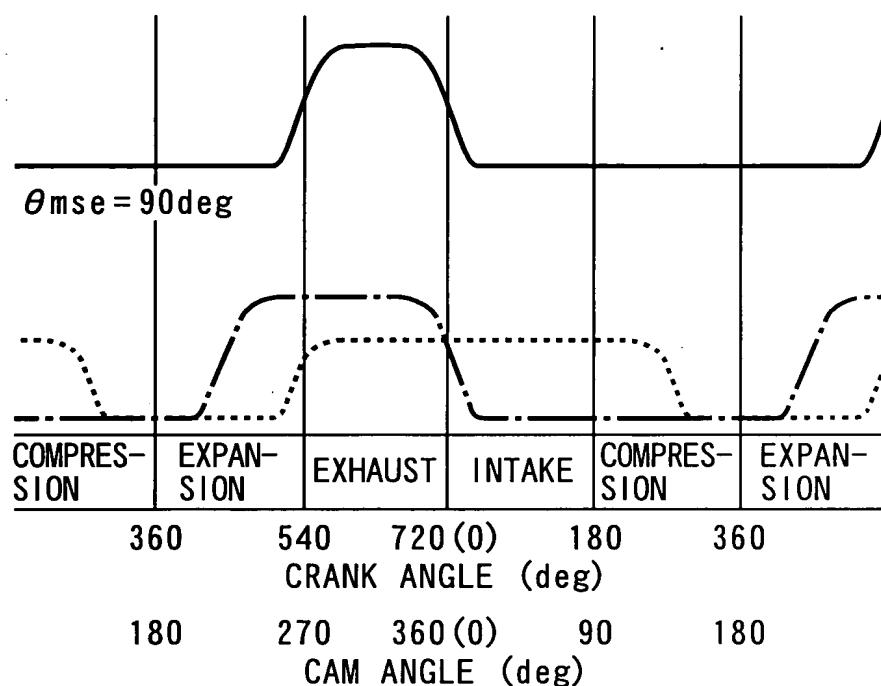
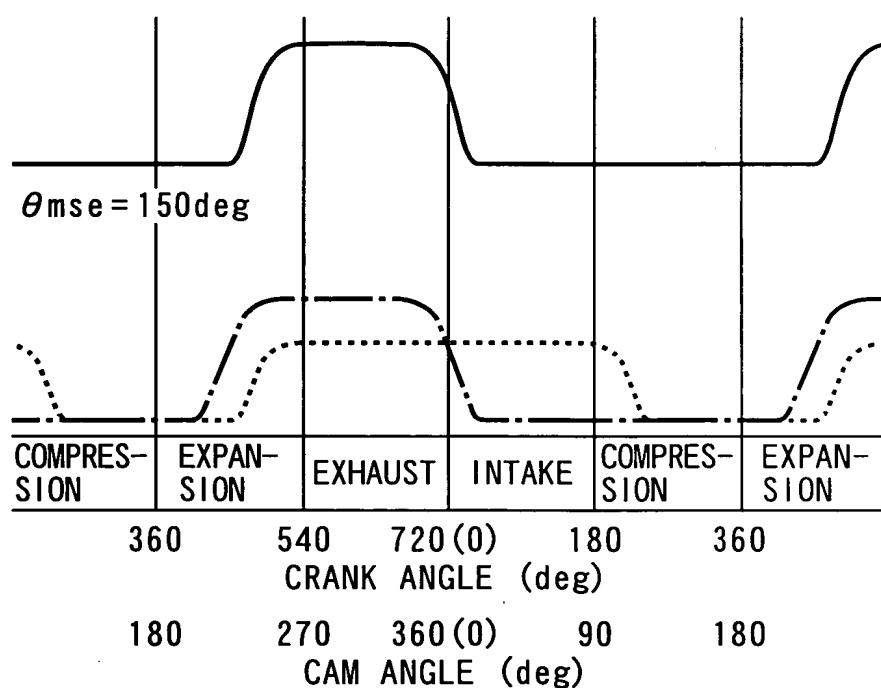


FIG. 21



F I G. 2 2

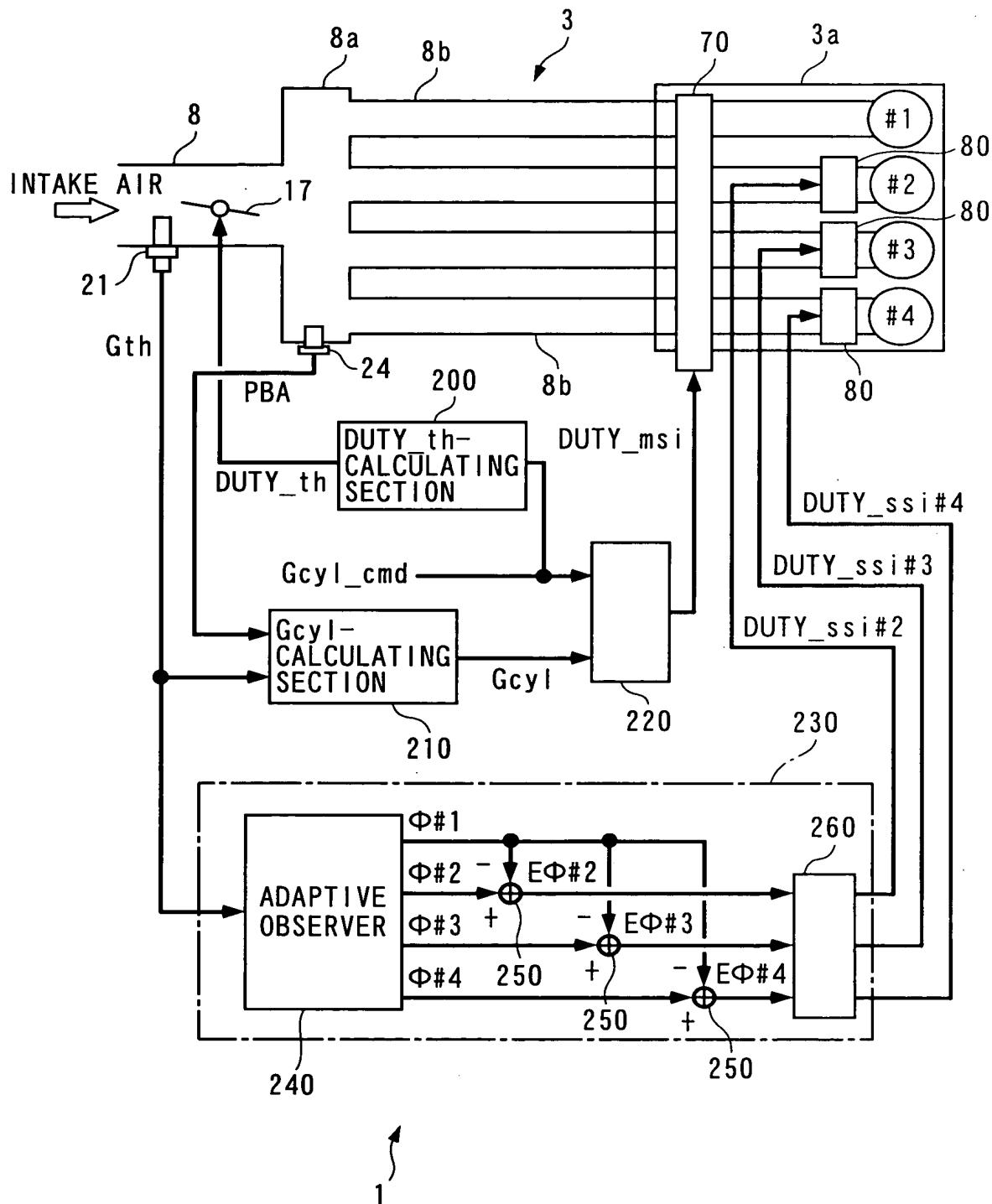
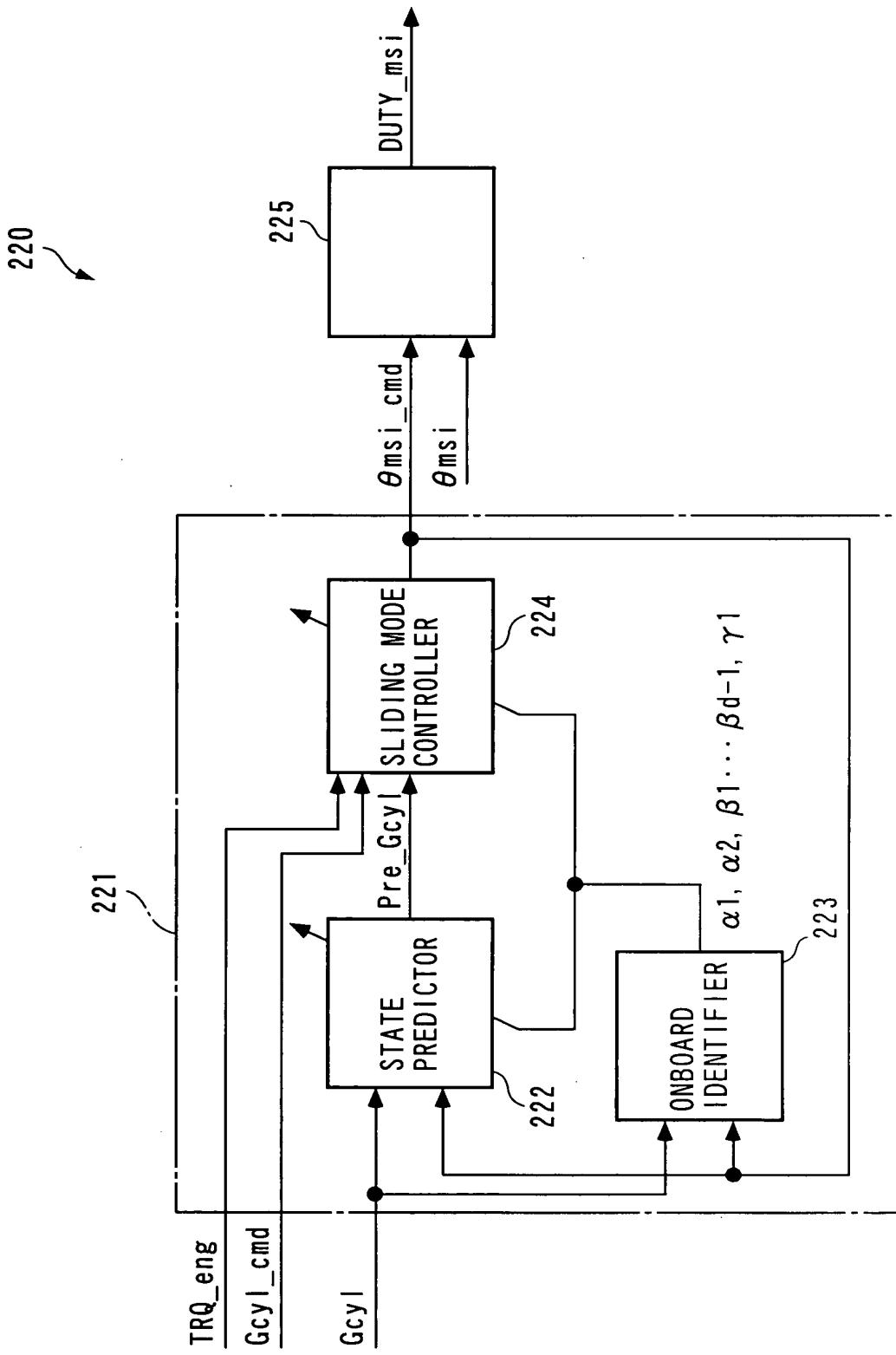


FIG. 23



F I G. 2 4

$$G_{cyl}(n) = G_{th}(n) - \frac{VB \cdot [PBA(n) - PBA(n-1)]}{R \cdot TB} \quad \dots \dots (1)$$

$$G_{cyl}(n) = a_1 \cdot G_{cyl}(n-1) + a_2 \cdot G_{cyl}(n-2) + b_1 \cdot \theta_{msi}(n-d) \quad \dots \dots (2)$$

$$G_{cyl}(n+d-1) = a_1 \cdot G_{cyl}(n+d-2) + a_2 \cdot G_{cyl}(n+d-3) + b_1 \cdot \theta_{msi}(n-1) \quad \dots \dots (3)$$

$$A = \begin{bmatrix} a_1 & a_2 \\ 1 & 0 \end{bmatrix} \quad \dots \dots (4)$$

$$B = \begin{bmatrix} b_1 \\ 0 \end{bmatrix} \quad \dots \dots (5)$$

$$\begin{aligned} G_{cyl}(n+d-1) = & \alpha_1 \cdot G_{cyl}(n) + \alpha_2 \cdot G_{cyl}(n-1) \\ & + \beta_1 \cdot \theta_{msi}(n-1) + \beta_2 \cdot \theta_{msi}(n-2) \\ & + \dots + \beta_{d-1} \cdot \theta_{msi}(n-d+1) \end{aligned} \quad \dots \dots (6)$$

α_1 : FIRST-ROW FIRST-COLUMN ELEMENT OF A^{d-1}
 α_2 : FIRST-ROW SECOND-COLUMN ELEMENT OF A^{d-1}
 β_j : FIRST-ROW ELEMENT OF $A^{j-1} B$ ($j = 0 \sim d-1$)

$$\begin{aligned} Pre_G_{cyl}(n) = & \alpha_1 \cdot G_{cyl}(n) + \alpha_2 \cdot G_{cyl}(n-1) \\ & + \beta_1 \cdot \theta_{msi}(n-1) + \beta_2 \cdot \theta_{msi}(n-2) \\ & + \dots + \beta_{d-1} \cdot \theta_{msi}(n-d+1) + \gamma_1 \\ \cong & G_{cyl}(n+d-1) \end{aligned} \quad \dots \dots (7)$$

F I G. 25

$$\theta s(n) = \theta s(n-1) + KPs(n) \cdot ide(n) \quad \dots \dots (8)$$

$$KPs(n) = \frac{Ps(n) \cdot \zeta s(n)}{1 + \zeta s(n)^T \cdot Ps(n) \cdot \zeta s(n)} \quad \dots \dots (9)$$

$$Ps(n+1) = \frac{1}{\lambda 1} \left[I - \frac{\lambda 2 \cdot Ps(n) \cdot \zeta s(n) \cdot \zeta s(n)^T}{\lambda 1 + \lambda 2 \cdot \zeta s(n)^T \cdot Ps(n) \cdot \zeta s(n)} \right] Ps(n) \quad \dots \dots (10)$$

I : UNIT MATRIX OF ORDER d+2
 $\lambda 1, \lambda 2$: WEIGHTING PARAMETER

$$\begin{aligned} ide(n) &= Pre_Gcyl(n-d+1) - Gcyl(n) \\ &= \theta s(n-1)^T \cdot \zeta s(n) - Gcyl(n) \end{aligned} \quad \dots \dots (11)$$

$$\theta s(n)^T = [\alpha 1, \alpha 2, \beta 1, \beta 2, \dots, \beta d-1, \gamma 1] \quad \dots \dots (12)$$

$$\begin{aligned} \zeta s(n)^T &= [Gcyl(n-d), Gcyl(n-d-1), \\ &\quad \theta_{msi}(n-d), \theta_{msi}(n-d-1), \dots, \theta_{msi}(n-2d+2), 1] \end{aligned} \quad \dots \dots (13)$$

F I G. 2 6

$$\begin{aligned}
 G_{cyl}(n+d) = & \alpha_1 \cdot G_{cyl}(n+1) + \alpha_2 \cdot G_{cyl}(n) \\
 & + \beta_1 \cdot \theta_{msi}(n) + \beta_2 \cdot \theta_{msi}(n-1) \\
 & + \dots + \beta_{d-1} \cdot \theta_{msi}(n-d+2) + \gamma_1
 \end{aligned} \quad \dots \dots (14)$$

$$E_s(n) = G_{cyl}(n) - G_{cyl_cmd}(n) \quad \dots \dots (15)$$

$$\sigma_s(n) = E_s(n) + S_s \cdot E_s(n-1) \quad \dots \dots (16)$$

$$-1 < S_s < 0 \quad \dots \dots (17)$$

$$\begin{aligned}
 \theta_{msi_cmd}(n) = & U_{spas}(n) \\
 = & U_{eq}(n) + U_{rch}(n) + U_{vt}(n)
 \end{aligned} \quad \dots \dots (18)$$

$$\begin{aligned}
 U_{eq}(n) = & \frac{1}{\beta_1} \{ P_{re_G_{cyl}}(n) + S_s \cdot P_{re_G_{cyl}}(n-1) \\
 & - \alpha_1 \cdot P_{re_G_{cyl}}(n-d+1) - \alpha_2 \cdot G_{cyl}(n) \\
 & - \beta_2 \cdot \theta_{msi}(n-1) - \dots - \beta_{d-1} \cdot \theta_{msi}(n-d+2) - \gamma_1 \\
 & + G_{cyl_cmd}(n+d) + (S_s - 1) \cdot G_{cyl_cmd}(n+d-1) \\
 & - S_s \cdot G_{cyl_cmd}(n+d-2) \}
 \end{aligned} \quad \dots \dots (19)$$

$$U_{rch}(n) = \frac{-F}{\beta_1} \cdot \sigma_s(n+d-1) \quad \dots \dots (20)$$

F : REACHING LAW GAIN (0 < F < 2)

$$U_{vt}(n) = \theta_{msi_base}(n) \quad \dots \dots (21)$$

F I G. 27

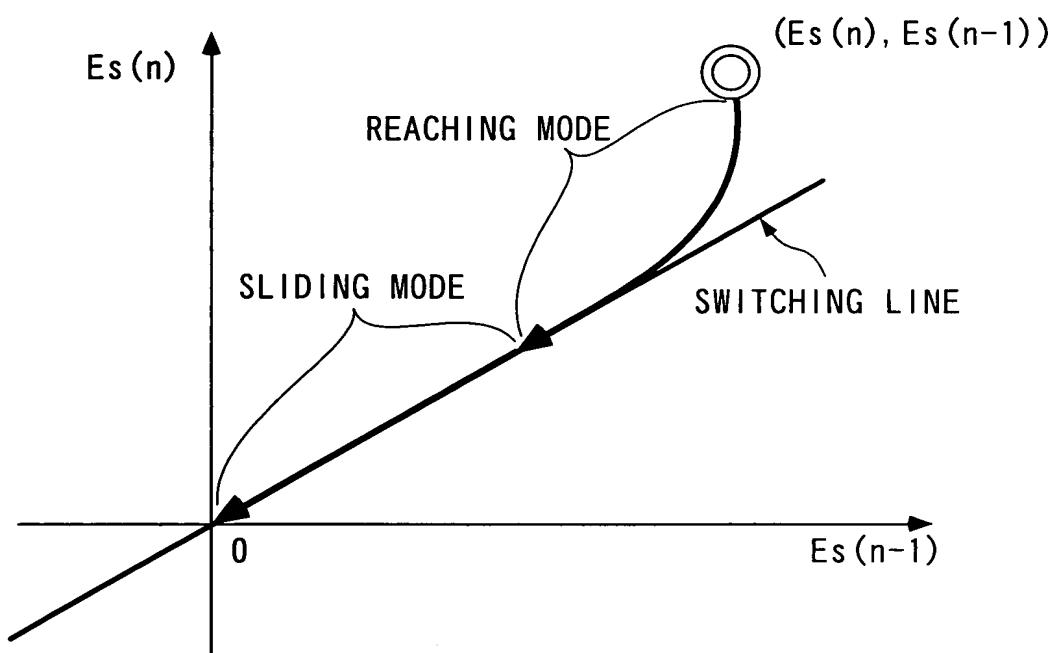
$$\sigma s(n+d) = \sigma s(n+d-1) \quad \dots \dots (22)$$

$$E_s(n+d) + S_s \cdot E_s(n+d-1) = E_s(n+d-1) + S_s \cdot E_s(n+d-2) \quad \dots \dots (23)$$

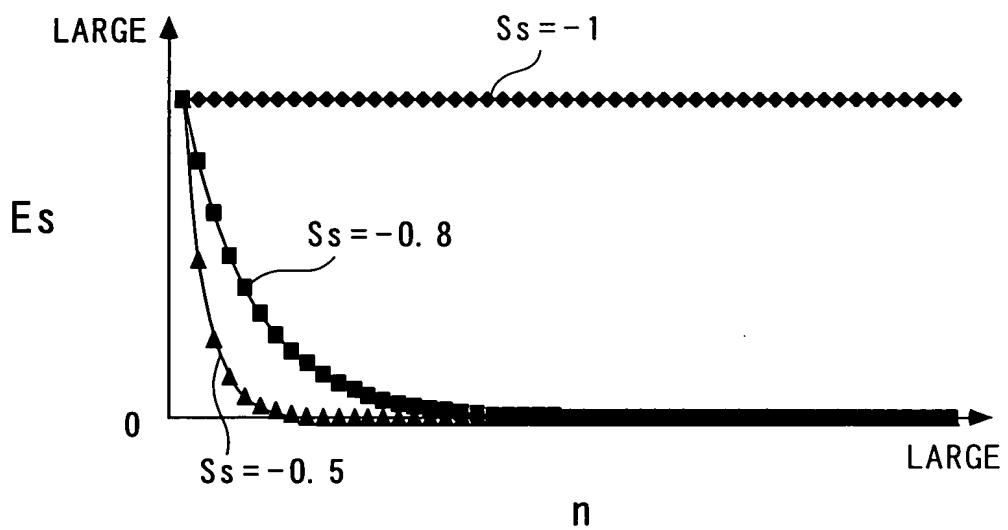
$$\begin{aligned} & \alpha_1 \cdot G_{cyl}(n+1) + \alpha_2 \cdot G_{cyl}(n) + \beta_1 \cdot \theta_{msi}(n) + \beta_2 \cdot \theta_{msi}(n-1) \\ & + \dots + \beta_{d-1} \cdot \theta_{msi}(n-d+2) + \gamma_1 \cdot G_{cyl_cmd}(n+d) \\ & + S_s \cdot G_{cyl}(n+d-1) - S_s \cdot G_{cyl_cmd}(n+d-1) \\ & = G_{cyl}(n+d-1) - G_{cyl_cmd}(n+d-1) \\ & + S_s \cdot G_{cyl}(n+d-2) - S_s \cdot G_{cyl_cmd}(n+d-2) \quad \dots \dots (24) \end{aligned}$$

$$\begin{aligned} \theta_{msi}(n) = & \frac{1}{\beta_1} \{ G_{cyl}(n+d-1) + S_s \cdot G_{cyl}(n+d-2) \\ & - \alpha_1 \cdot G_{cyl}(n+1) - \alpha_2 \cdot G_{cyl}(n) \\ & - \beta_2 \cdot \theta_{msi}(n-1) - \dots - \beta_{d-1} \cdot \theta_{msi}(n-d+2) - \gamma_1 \\ & + G_{cyl_cmd}(n+d) + (S_s - 1) \cdot G_{cyl_cmd}(n+d-1) \\ & - S_s \cdot G_{cyl_cmd}(n+d-2) \} \quad \dots \dots (25) \end{aligned}$$

F I G. 2 8



F I G. 2 9



F I G . 3 0

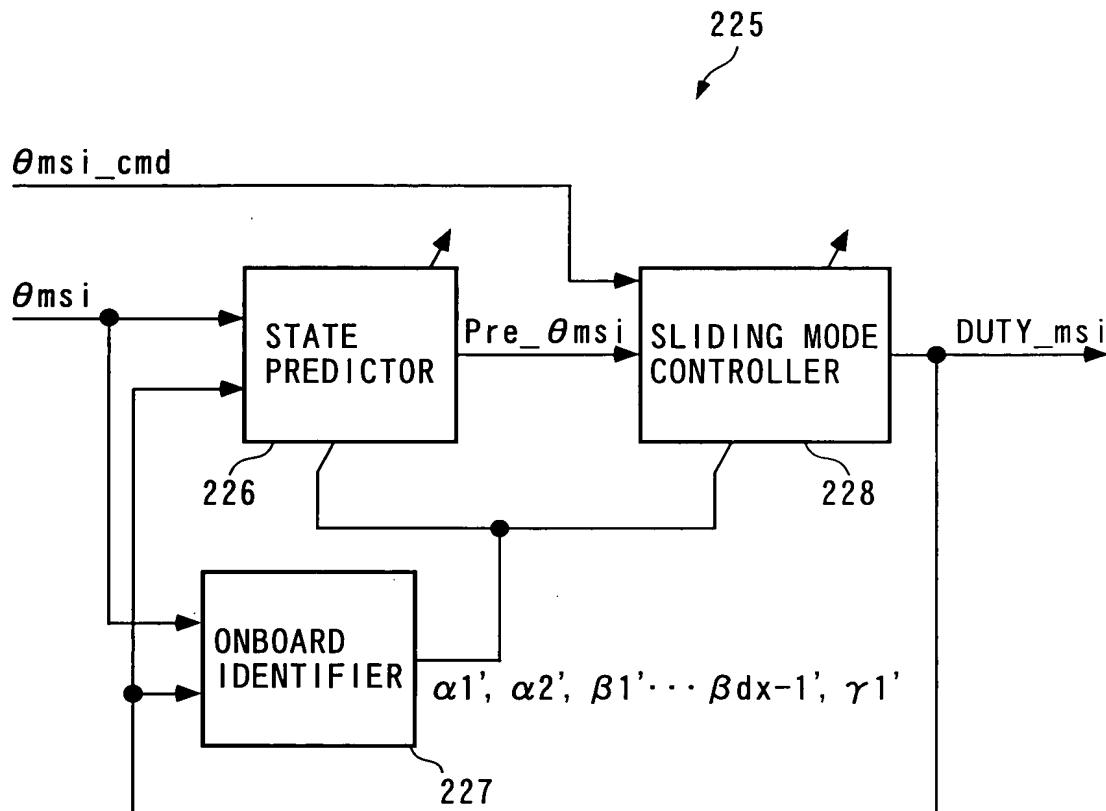


FIG. 31

$$\theta_{msi}(m) = a1' \cdot \theta_{msi}(m-1) + a2' \cdot \theta_{msi}(m-2) + b1' \cdot DUTY_{msi}(m-dx) \quad \dots \dots (26)$$

$$A' = \begin{bmatrix} a1' & a2' \\ 1 & 0 \end{bmatrix} \quad \dots \dots (27)$$

$$B' = \begin{bmatrix} b1' \\ 0 \end{bmatrix} \quad \dots \dots (28)$$

$$\begin{aligned} Pre_{-}\theta_{msi}(m) &= \alpha1' \cdot \theta_{msi}(m) + \alpha2' \cdot \theta_{msi}(m-1) \\ &\quad + \beta1' \cdot DUTY_{msi}(m-1) + \beta2' \cdot DUTY_{msi}(m-2) \\ &\quad + \dots + \beta_{dx-1}' \cdot DUTY_{msi}(m-dx+1) + \gamma1' \\ &\doteq \theta_{msi}(m+dx-1) \quad \dots \dots (29) \end{aligned}$$

$\alpha1'$: FIRST-ROW FIRST-COLUMN ELEMENT OF A'^{dx-1}
 $\alpha2'$: FIRST-ROW SECOND-COLUMN ELEMENT OF A'^{dx-1}
 β_j' : FIRST-ROW ELEMENT OF $A'^{j'-1} B'$ ($j' = 0 \sim dx-1$)

F I G. 32

$$\theta s'(m) = \theta s'(m-1) + KPs'(m) \cdot ide'(m) \quad \dots \dots (30)$$

$$KPs'(m) = \frac{Ps'(m) \cdot \zeta s'(m)}{1 + \zeta s'(m)^T \cdot Ps'(m) \cdot \zeta s'(m)} \quad \dots \dots (31)$$

$$Ps'(m+1) = \frac{1}{\lambda 1'} \left[I' - \frac{\lambda 2' \cdot Ps'(m) \cdot \zeta s'(m) \cdot \zeta s'(m)^T}{\lambda 1' + \lambda 2' \cdot \zeta s'(m)^T \cdot Ps'(m) \cdot \zeta s'(m)} \right] Ps'(m) \quad \dots \dots (32)$$

I' : UNIT MATRIX OF ORDER $dx+2$
 $\lambda 1'$, $\lambda 2'$: WEIGHTING PARAMETER

$$ide'(m) = Pre_theta ms i(m-dx+1) - theta ms i(m) \\ = \theta s'(m-1)^T \cdot \zeta s'(m) - \theta ms i(m) \quad \dots \dots (33)$$

$$\theta s'(m)^T = [\alpha 1', \alpha 2', \beta 1', \beta 2', \dots, \beta dx-1', \gamma 1'] \quad \dots \dots (34)$$

$$\zeta s'(m)^T = [\theta ms i(m-dx), \theta ms i(m-dx-1), \\ DUTY_ms i(m-dx), DUTY_ms i(m-dx-1), \dots \\ \dots, DUTY_ms i(m-2dx+2), 1] \quad \dots \dots (35)$$

F I G. 33

$$E_{s'}(m) = \theta_{msi}(m) - \theta_{msi_cmd}(m) \quad \dots \dots (36)$$

$$\sigma_{s'}(m) = E_{s'}(m) + S_{s'} \cdot E_{s'}(m-1) \quad \dots \dots (37)$$

$$-1 < S_{s'} < 0 \quad \dots \dots (38)$$

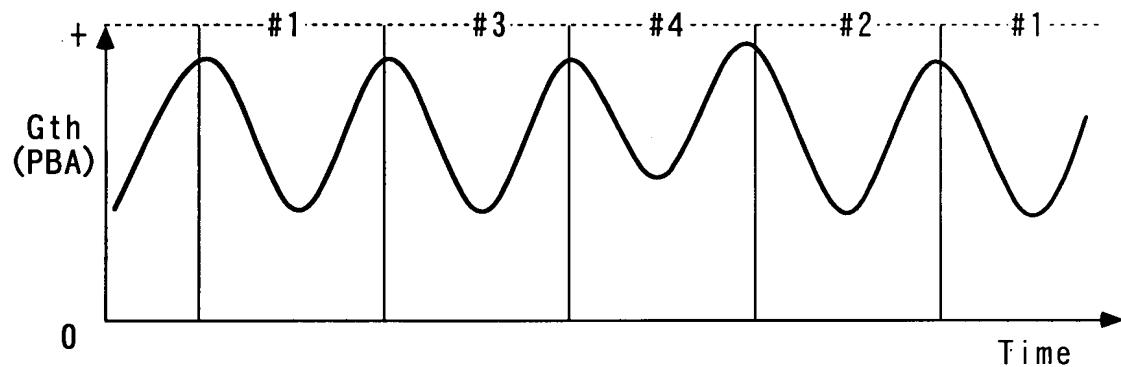
$$DUTY_{msi}(m) = U_{spas'}(m) = U_{eq'}(m) + U_{rch'}(m) \quad \dots \dots (39)$$

$$\begin{aligned} U_{eq'}(m) = \frac{1}{\beta_1} \{ & \text{Pre_} \theta_{msi}(m) + S_{s'} \cdot \text{Pre_} \theta_{msi}(m-1) \\ & - \alpha_1' \cdot \text{Pre_} \theta_{msi}(m-dx+1) - \alpha_2' \cdot \theta_{msi}(m) \\ & - \beta_2' \cdot DUTY_{msi}(m-1) - \dots - \beta_{dx-1}' \cdot DUTY_{msi}(m-dx+2) - \gamma_1' \\ & + \theta_{msi_cmd}(m+dx) + (S_{s'} - 1) \cdot \theta_{msi_cmd}(m+dx-1) \\ & - S_{s'} \cdot \theta_{msi_cmd}(m+dx-2) \} \end{aligned} \quad \dots \dots (40)$$

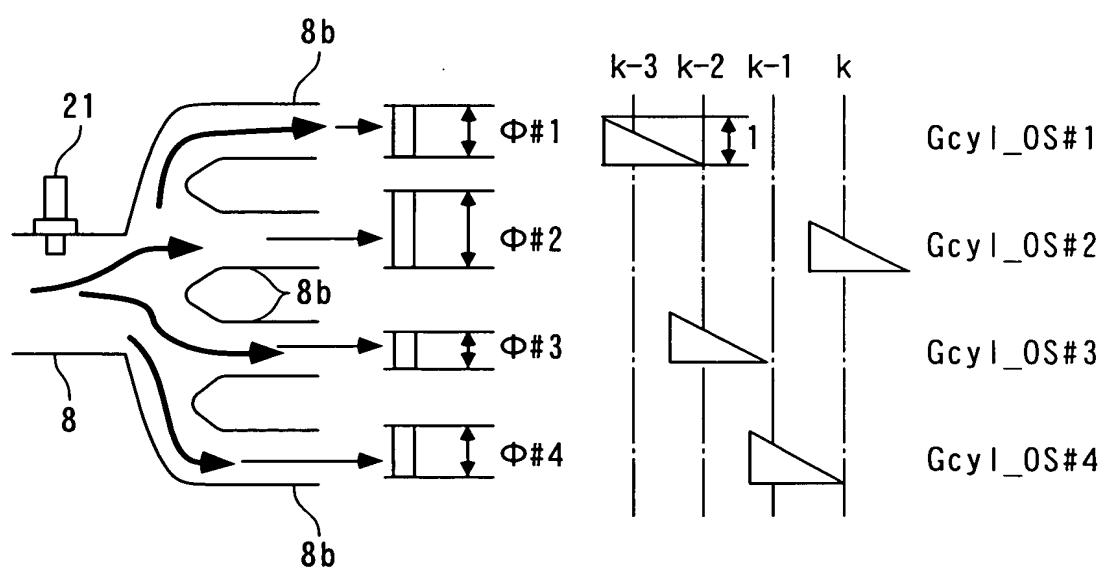
$$U_{rch'}(n) = \frac{-F'}{\beta_1} \cdot \sigma_{s'}(m+dx-1) \quad \dots \dots (41)$$

F' : REACHING LAW GAIN ($0 < F' < 2$)

F I G . 3 4



F I G . 3 5



F I G. 3 6

$$G_{th}(k-d') = \Phi\#1(k) \cdot G_{cy1_OS\#1}(k) + \Phi\#2(k) \cdot G_{cy1_OS\#2}(k) + \Phi\#3(k) \cdot G_{cy1_OS\#3}(k) + \Phi\#4(k) \cdot G_{cy1_OS\#4}(k)$$

..... (4 2)

$$G_{th_est}(k) = \Phi\#1(k) \cdot G_{cy1_OS\#1}(k) + \Phi\#2(k) \cdot G_{cy1_OS\#2}(k) + \Phi\#3(k) \cdot G_{cy1_OS\#3}(k) + \Phi\#4(k) \cdot G_{cy1_OS\#4}(k)$$

..... (4 3)

$$\phi(k) = \phi(k-1) + KR(k) \cdot ide'(k)$$

..... (4 4)

$$KR(k) = \frac{R(k) \cdot \zeta'(k)}{1 + \zeta'(k)^T \cdot R(k) \cdot \zeta'(k)}$$

$$ide'(k) = G_{th}(k-d') - G_{th_est}(k)$$

..... (4 6)

$$G_{th_est}(k) = \phi(k-1)^T \zeta'(k)$$

..... (4 7)

$$R(k+1) = \frac{1}{\lambda 1''} \left[I - \frac{\lambda 2'' \cdot R(k) \cdot \zeta'(k) \cdot \zeta'(k)^T}{\lambda 1'' + \lambda 2'' \cdot \zeta'(k)^T \cdot R(k) \cdot \zeta'(k)} \right] R(k)$$

..... (4 8)

I: UNIT MATRIX
 $\lambda 1''$, $\lambda 2''$: WEIGHTING PARAMETER

$$\phi(k)^T = [\Phi\#1(k), \Phi\#2(k), \Phi\#3(k), \Phi\#4(k)]$$

..... (4 9)

$$\zeta'(k)^T = [G_{cy1_OS\#1}(k), G_{cy1_OS\#2}(k), G_{cy1_OS\#3}(k), G_{cy1_OS\#4}(k)]$$

..... (5 0)

FIG. 37

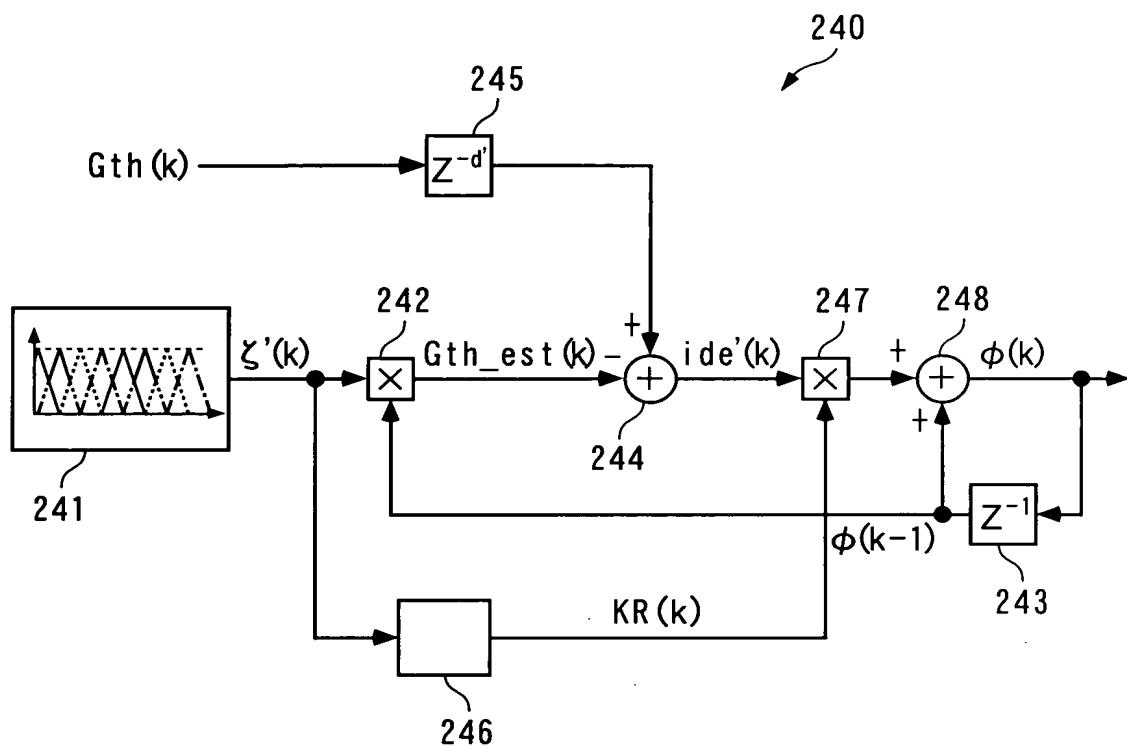
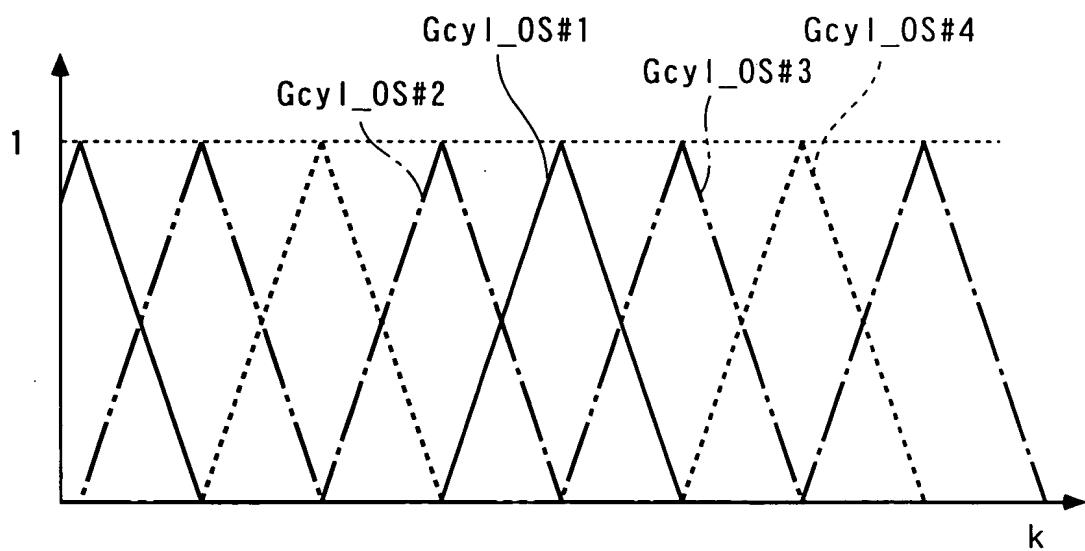


FIG. 38



F I G. 3 9

$$E\Phi\#i(k) = \Phi\#i(k) - \Phi\#1(k) \quad \dots \dots (51)$$

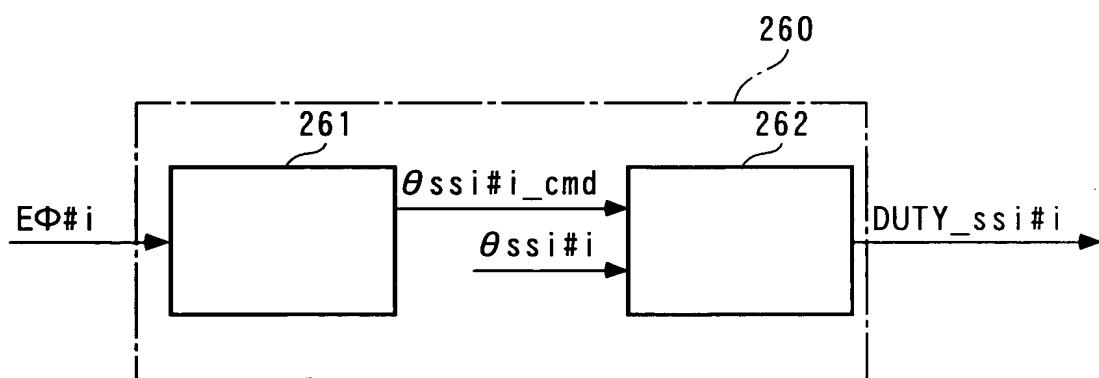
$$(i = 2 \sim 4)$$

$$\sigma'(k) = E\Phi\#i(k) + S'E\Phi\#i(k-1) \quad \dots \dots (52)$$

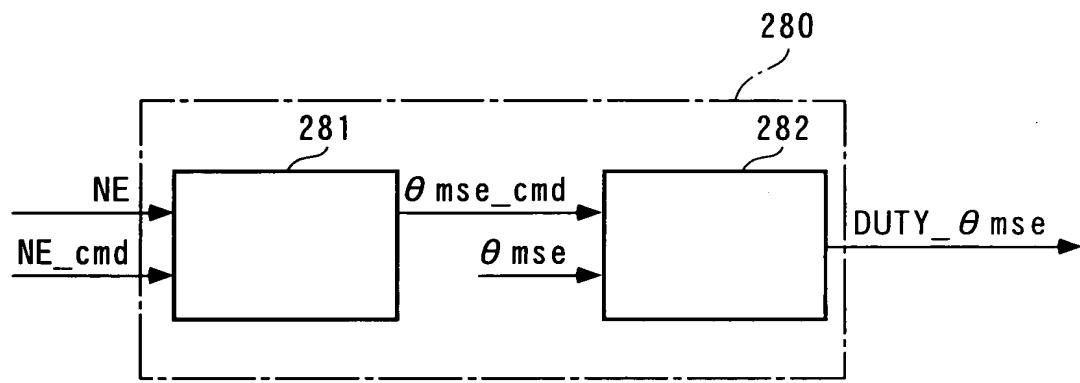
$$\theta_{ssi\#i_cmd}(k) = -Fs' \cdot \sigma'(k) - Gs' \cdot \sum_{j=0}^k \sigma'(j) - Hs' \cdot E\Phi\#i(k) \quad \dots \dots (53)$$

Fs', Gs', Hs' : FEEDBACK GAIN
 S' : SWITCHING FUNCTION-SETTING PARAMETER ($-1 < S' < 1$)

F I G. 4 0



F I G. 4 1



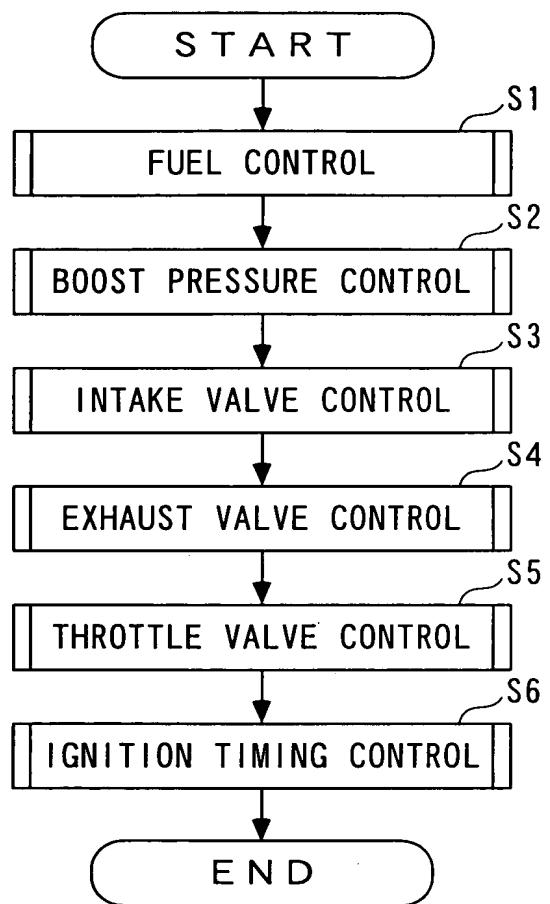
F I G. 4 2

$$\theta_{mse_cmd}(n) = \theta_{mse_ast}(n) + d\theta_{mse}(n) \quad \dots \dots (54)$$

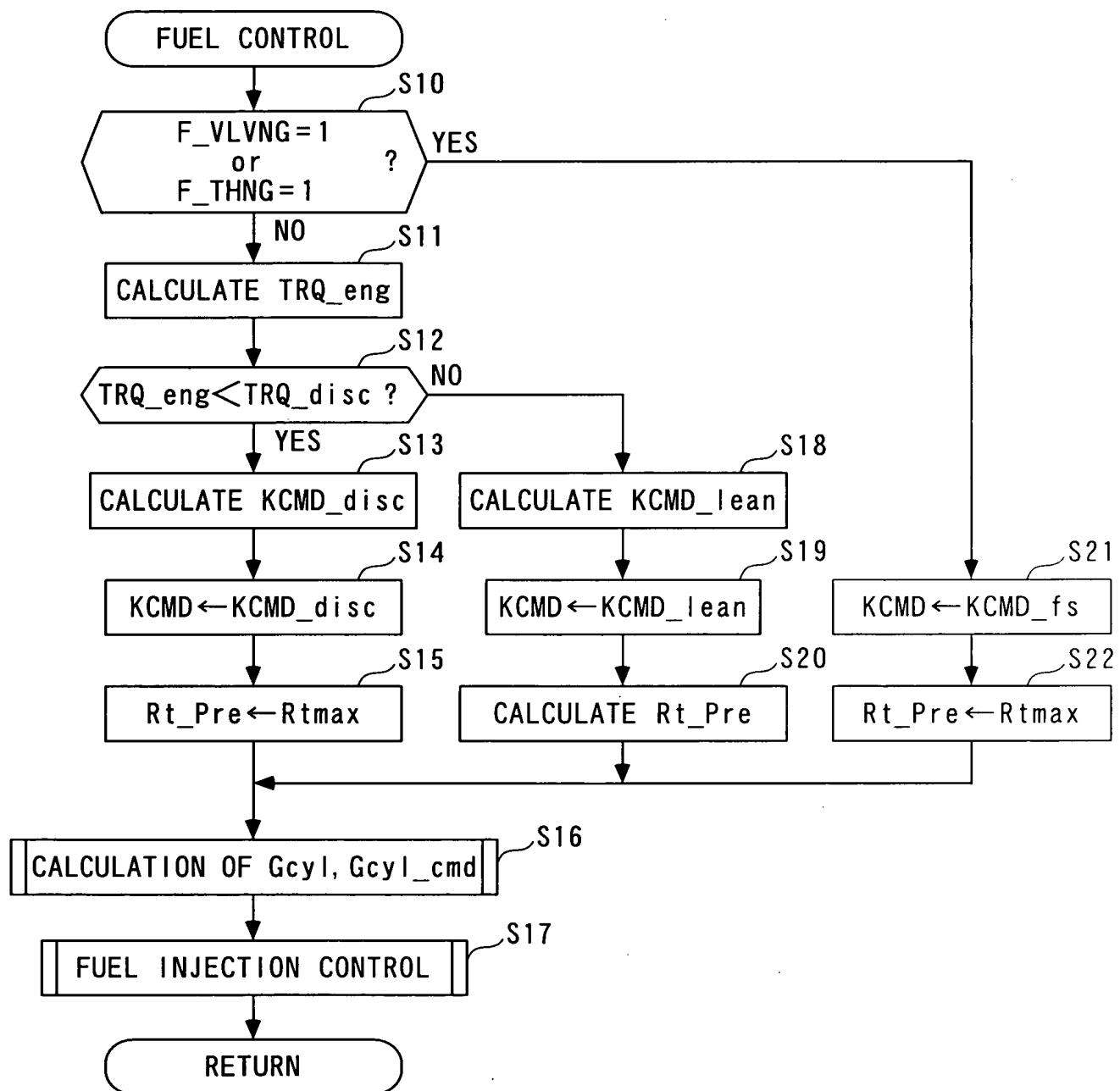
$$d\theta_{mse}(n) = -K_{astr} \cdot \sigma_{ast}(n) + \left[-K_{asta} \cdot \sum_{i=0}^n \sigma_{ast}(i) \right] \quad \dots \dots (55)$$

$$\sigma_{ast}(n) = NE(n) - NE_{cmd}(n) + S_{ast} \cdot [NE(n-1) - NE_{cmd}(n-1)] \quad \dots \dots (56)$$

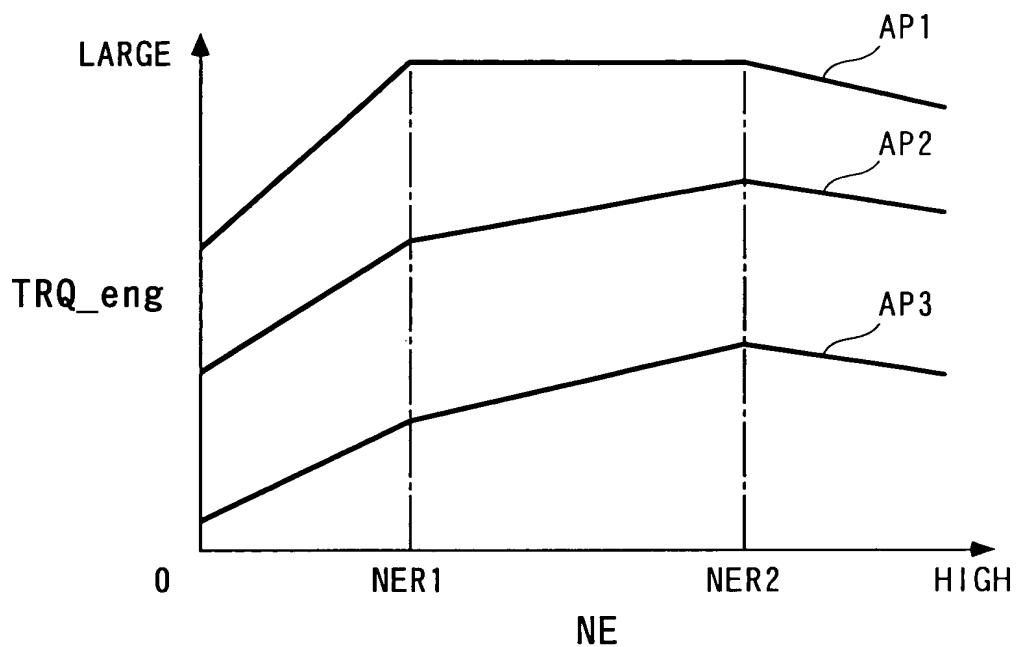
F I G . 4 3



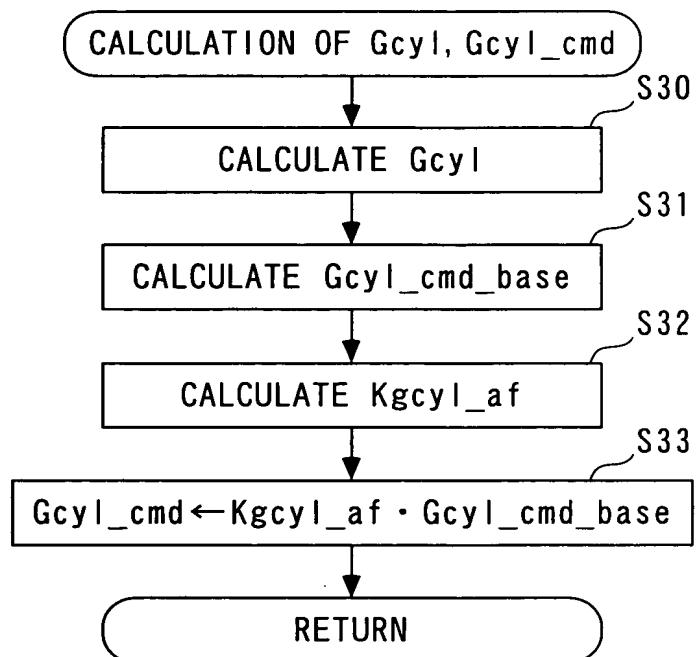
F I G. 4 4



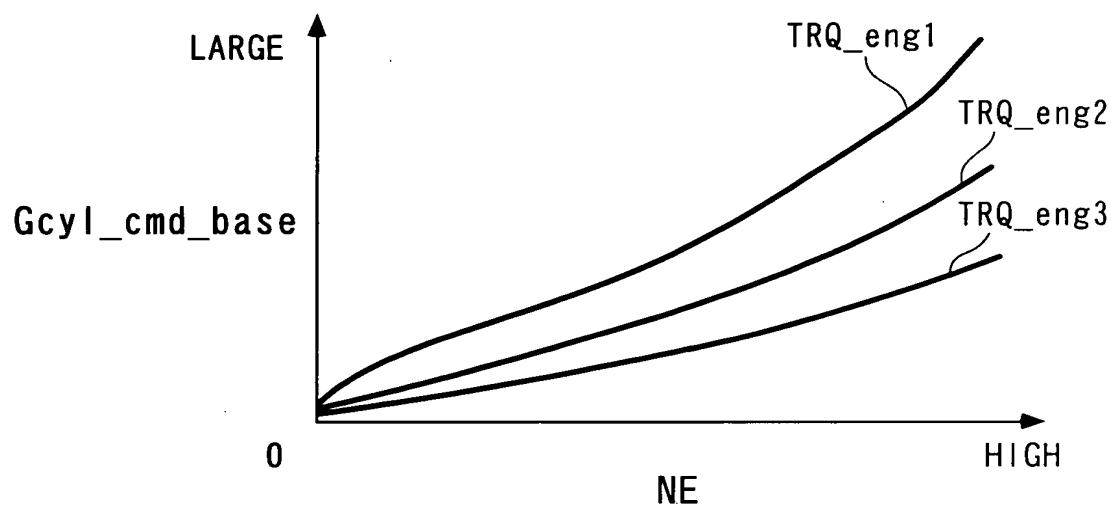
F I G. 4 5



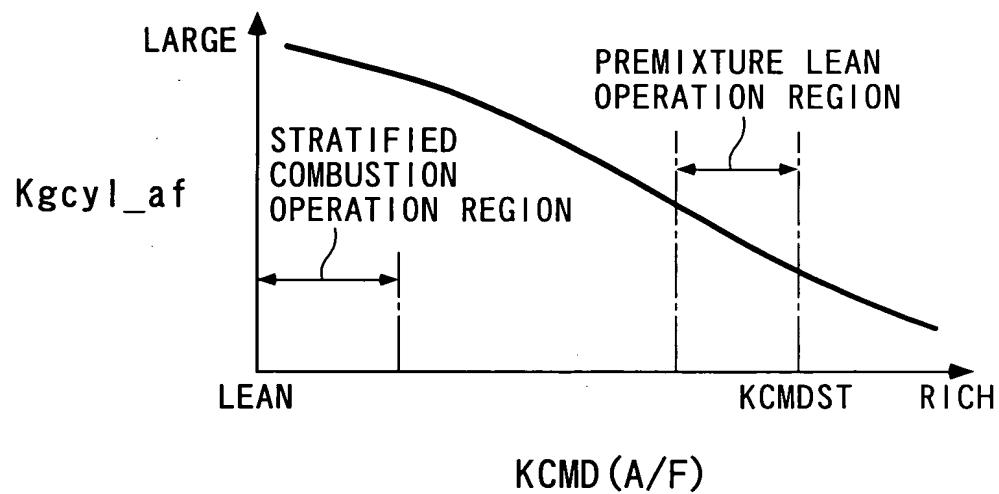
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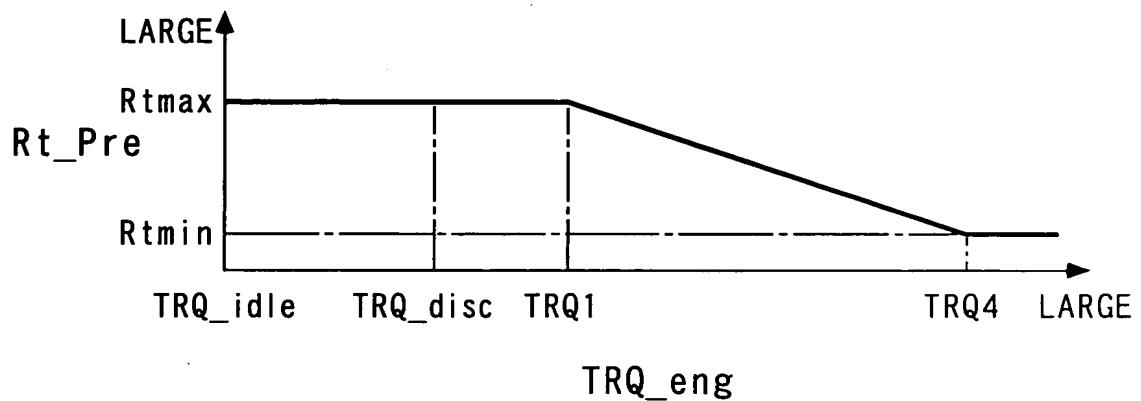
F I G. 4 7



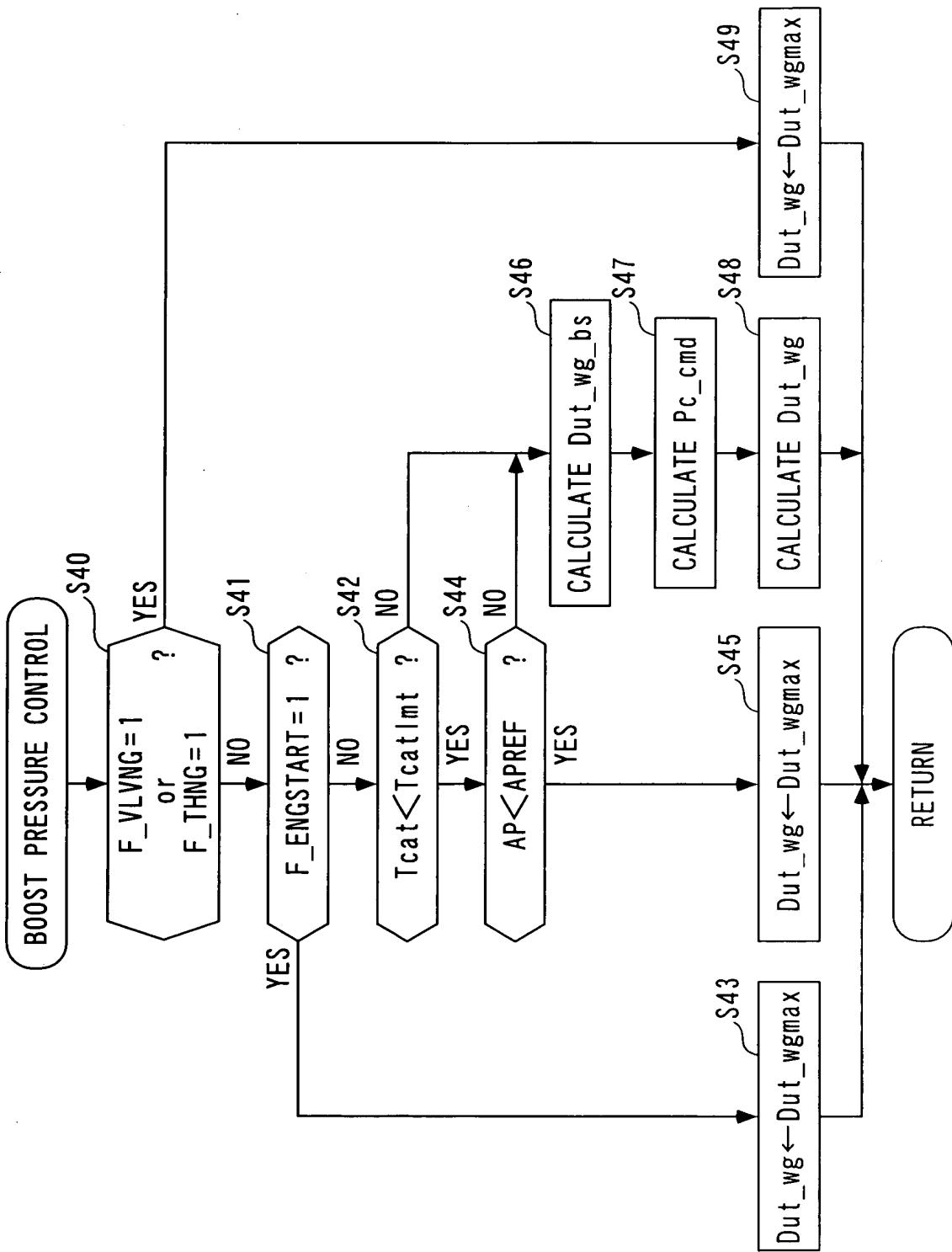
F I G. 4 8



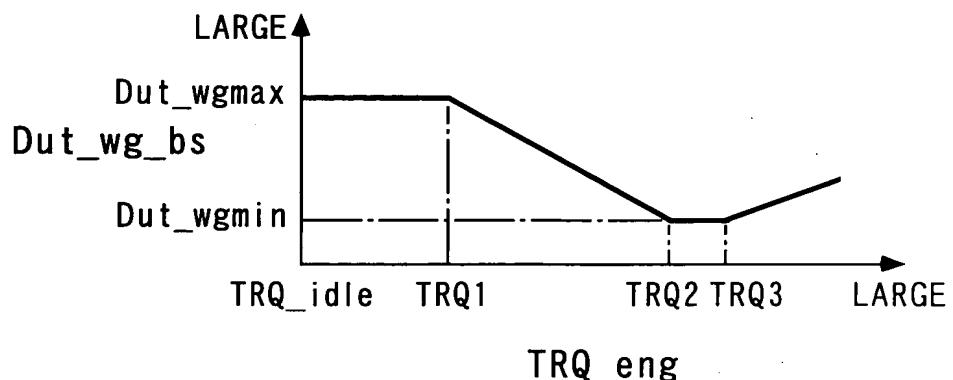
F I G. 4 9



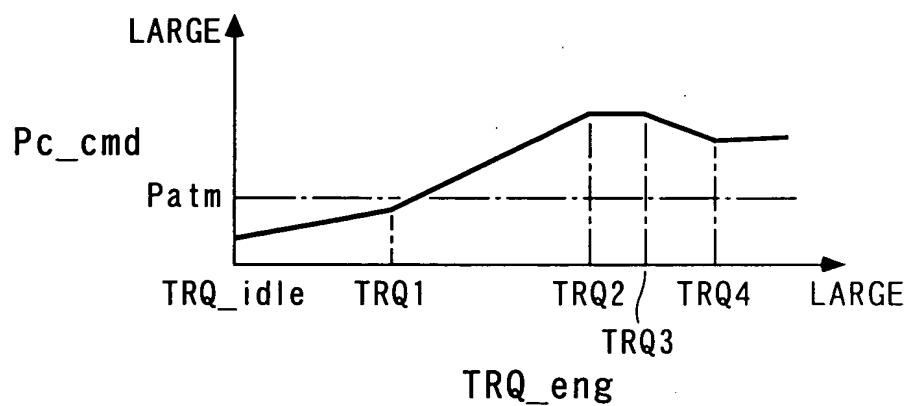
F I G. 5 0



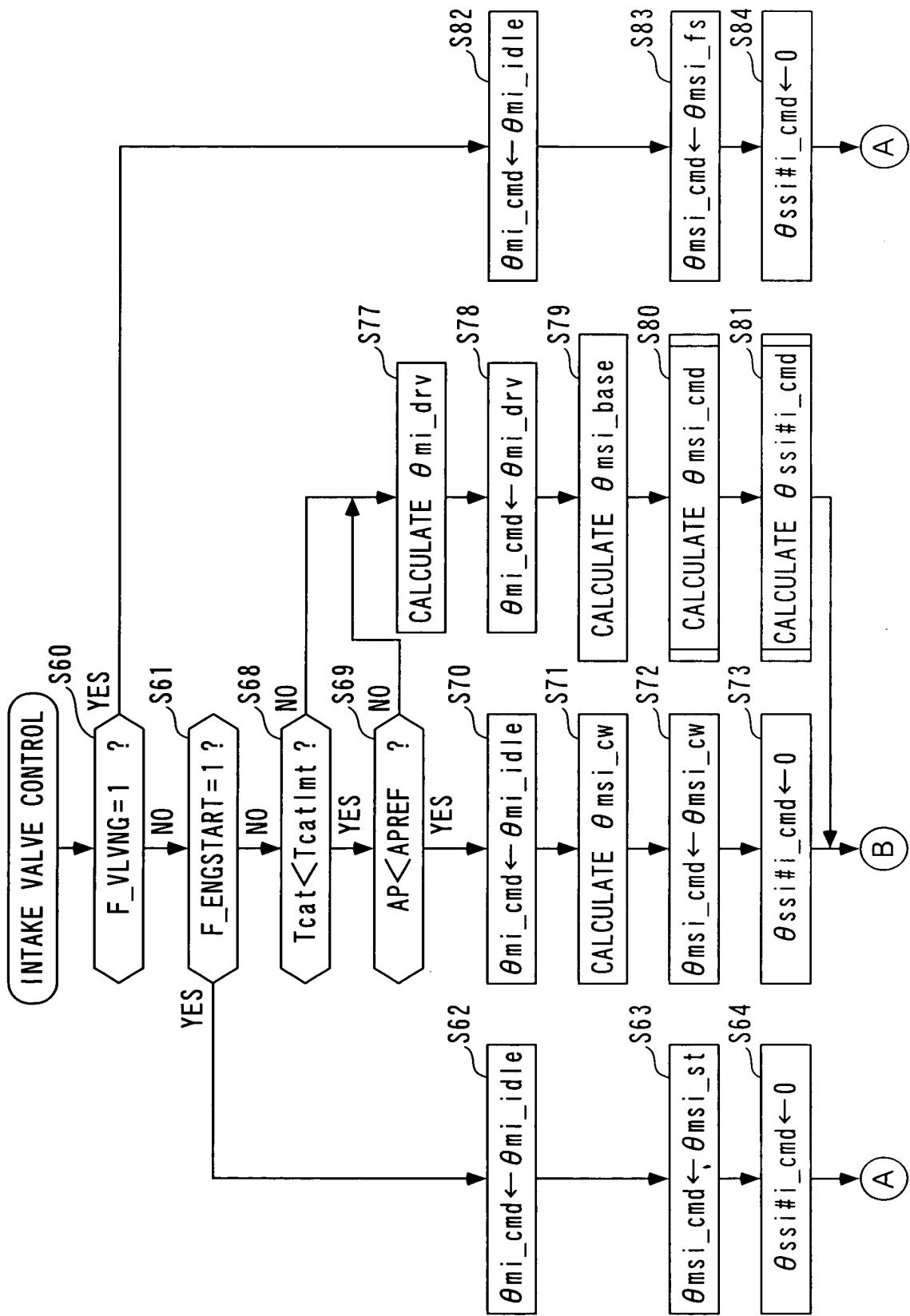
F I G. 5 1



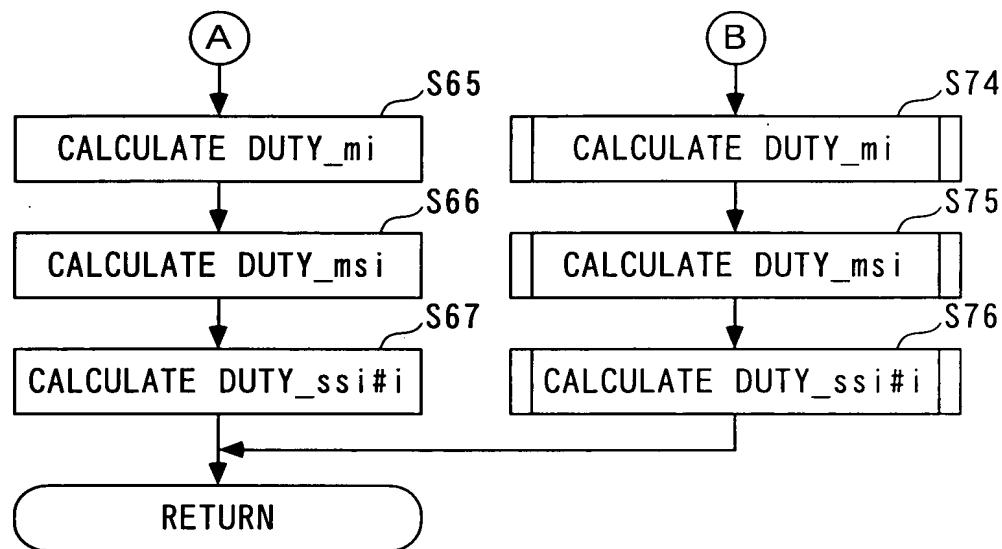
F I G. 5 2



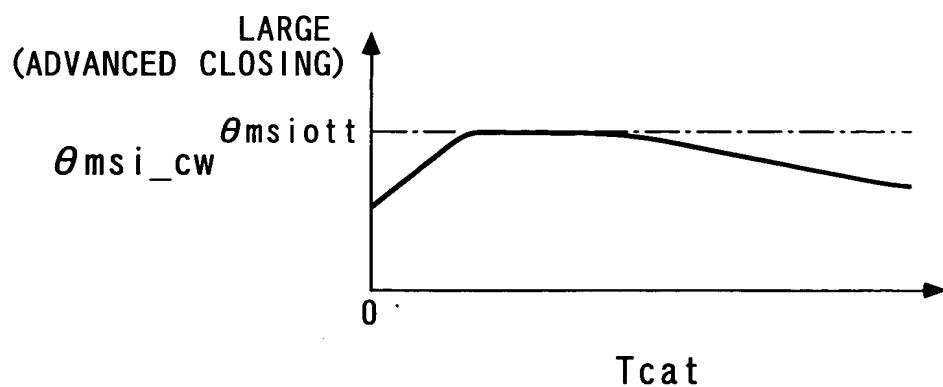
F - G. 53



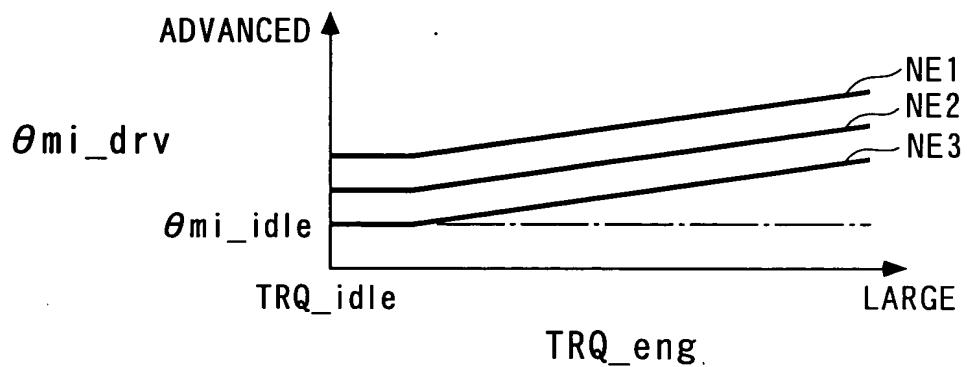
F I G. 5 4



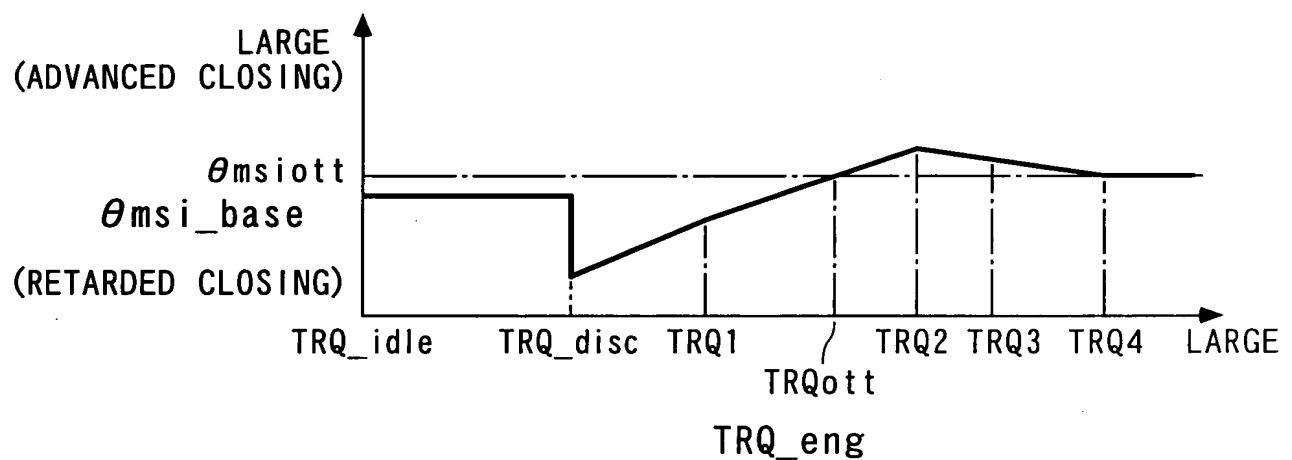
F I G. 55



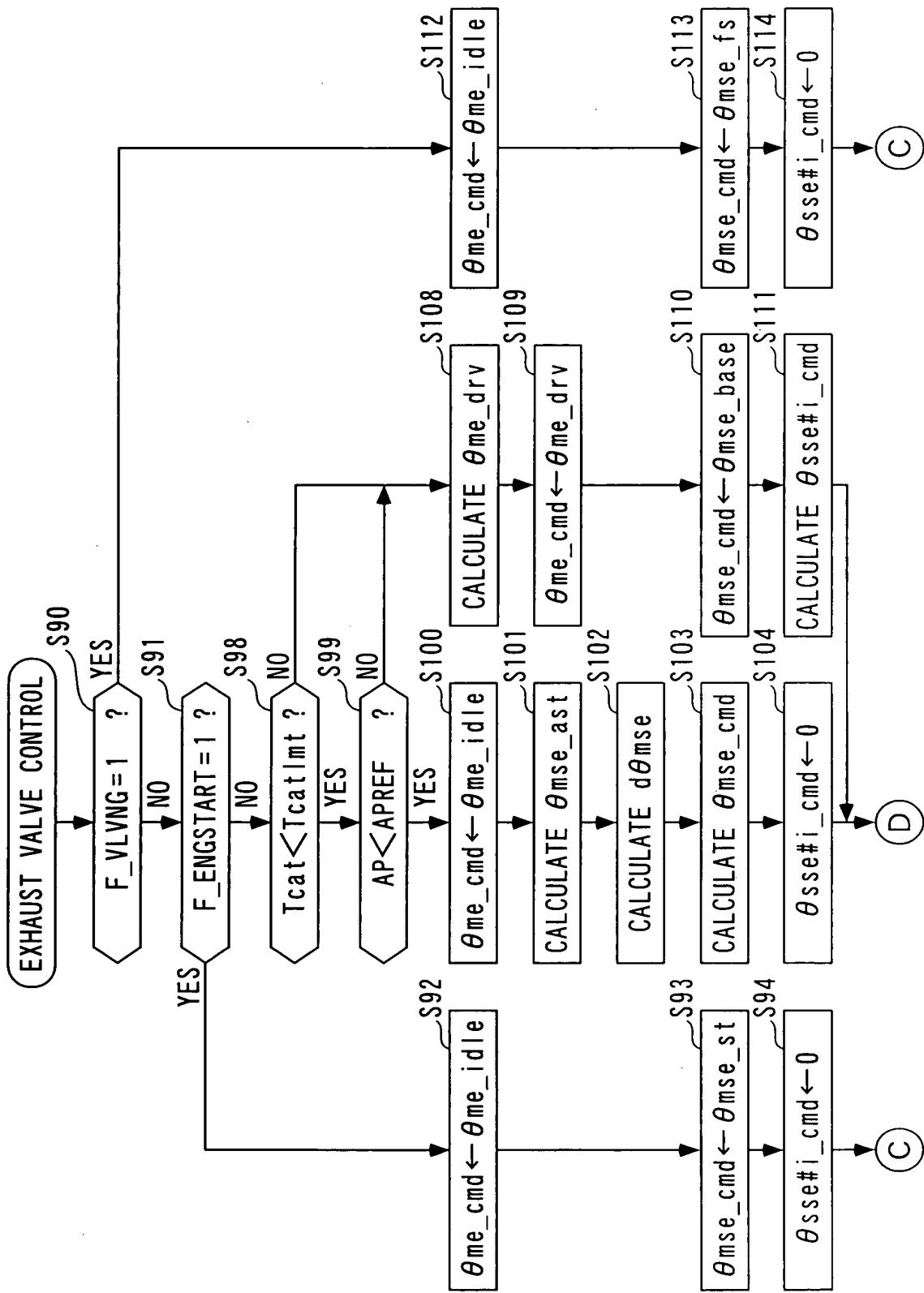
F I G. 56



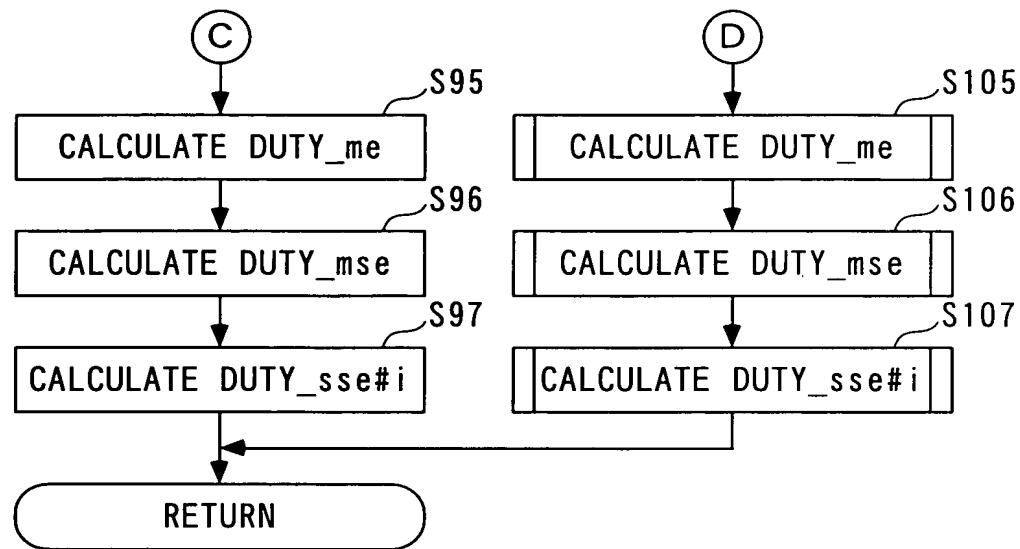
F I G. 57



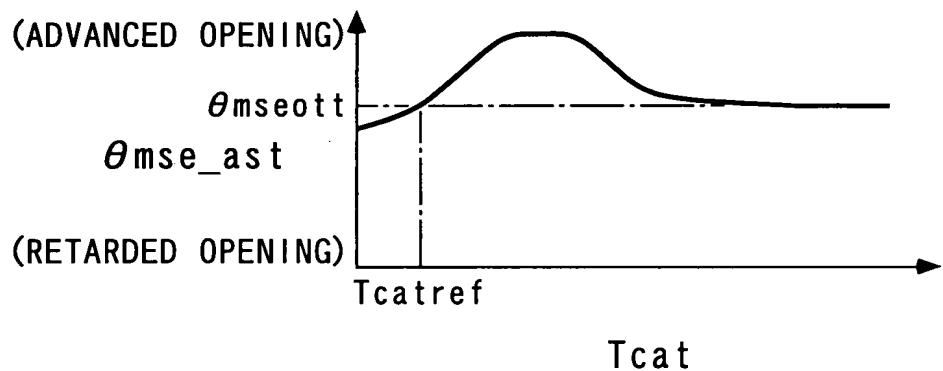
F - G. 58



F I G. 5 9



F I G. 6 0



F I G. 6 1

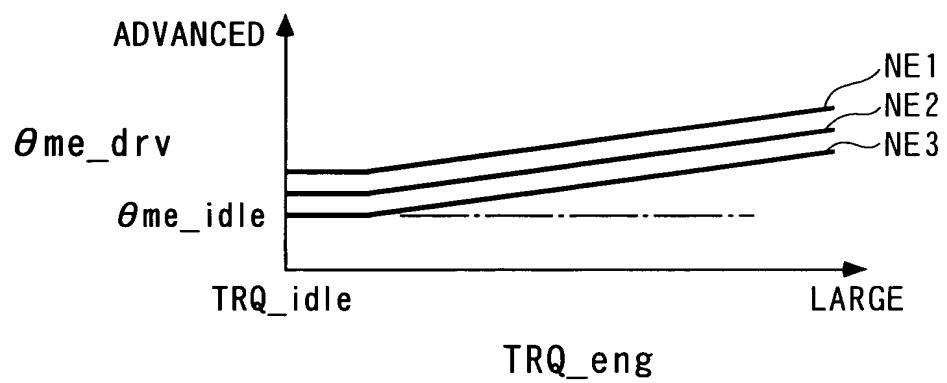
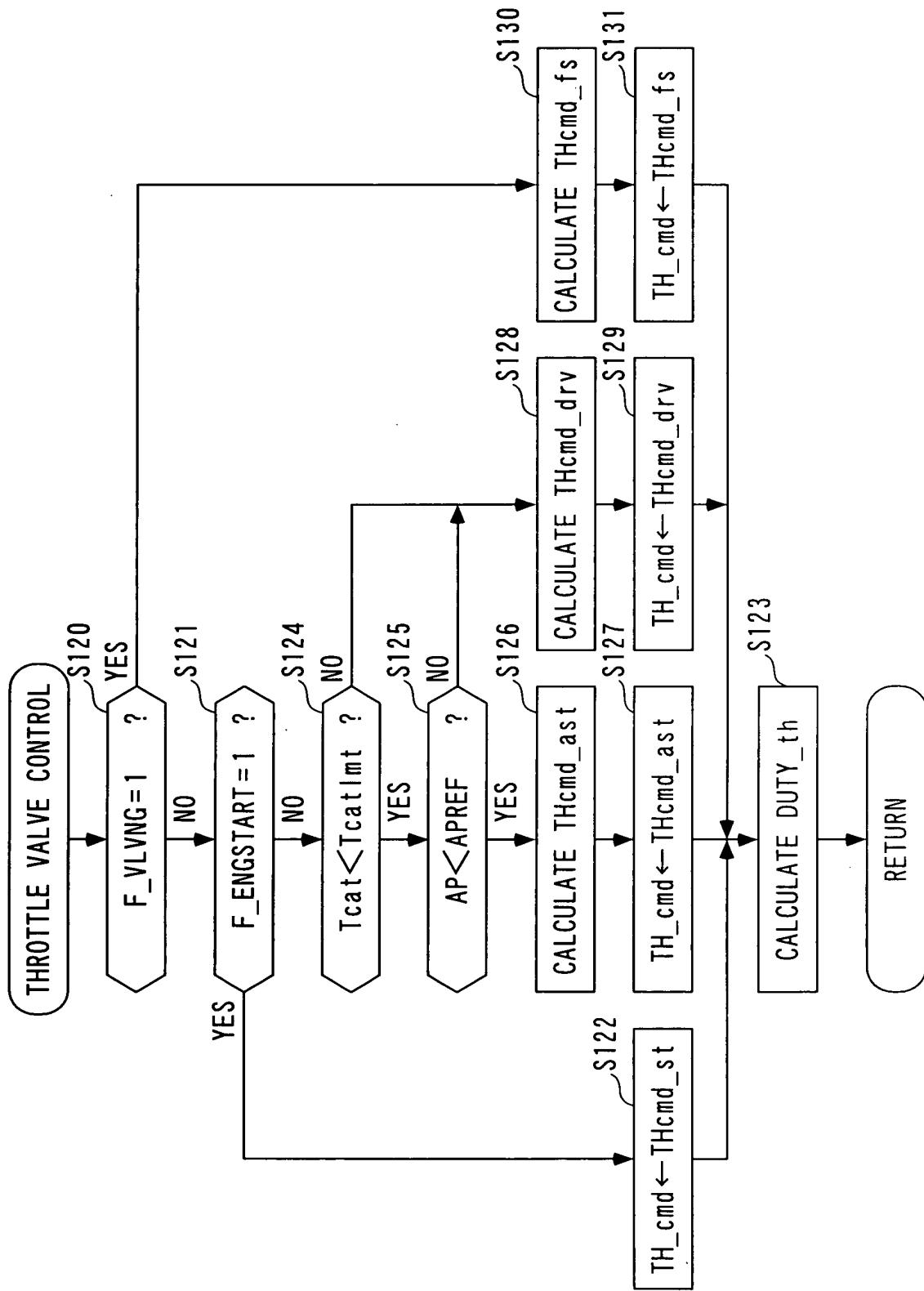
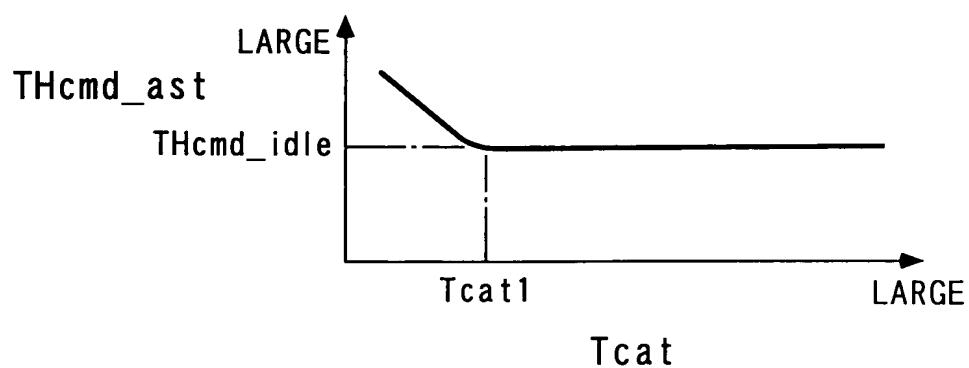


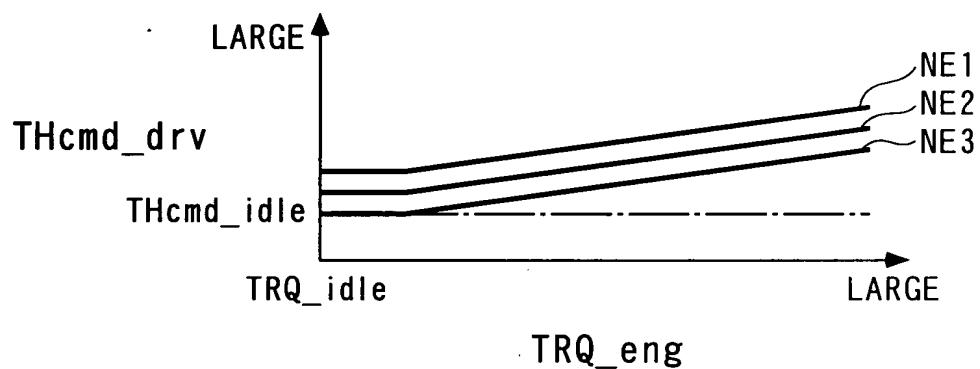
FIG. 62



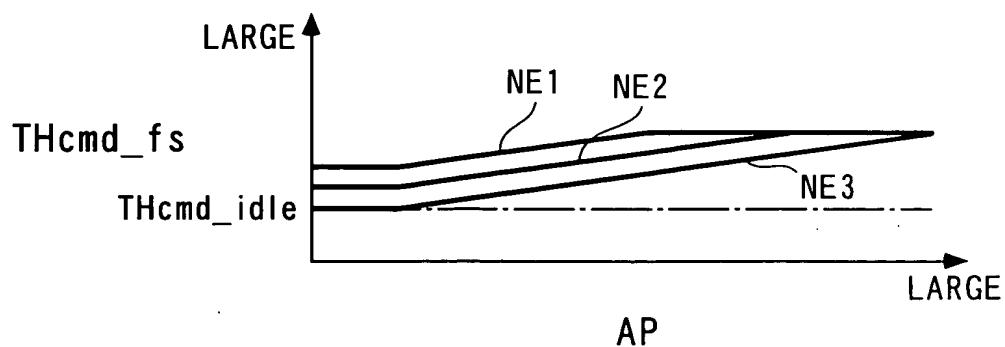
F I G . 6 3



F I G . 6 4



F I G . 6 5



F I G . 6 6

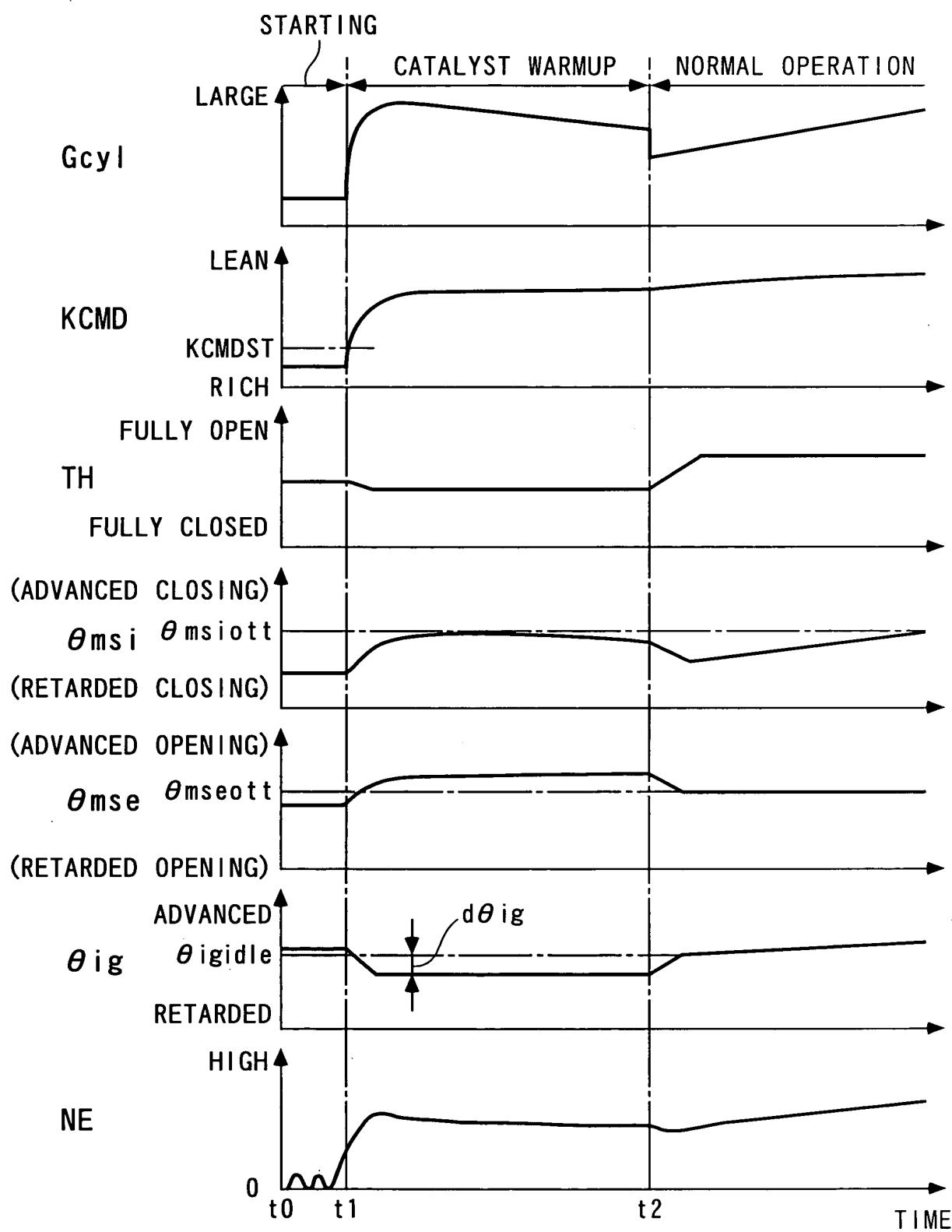
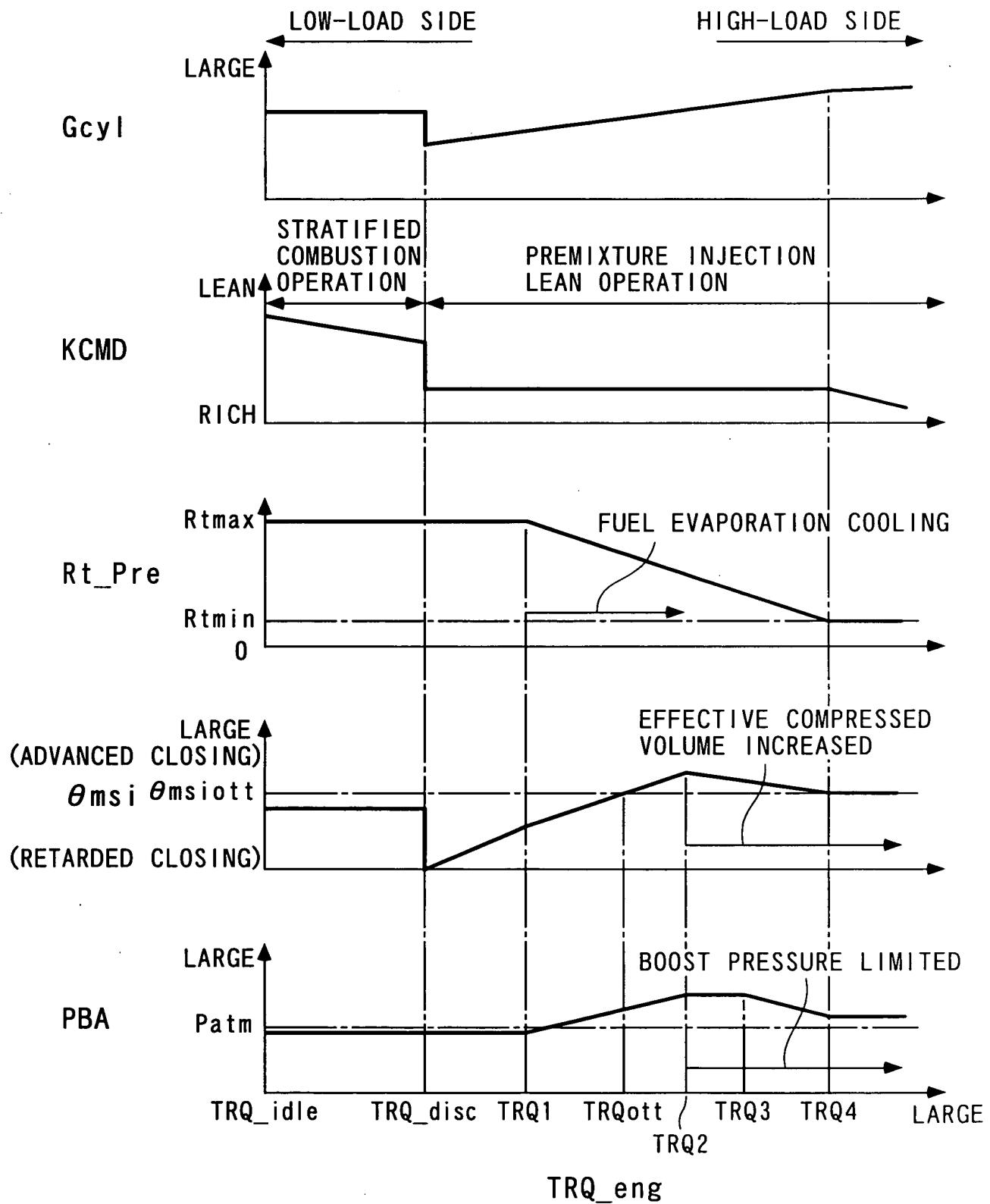
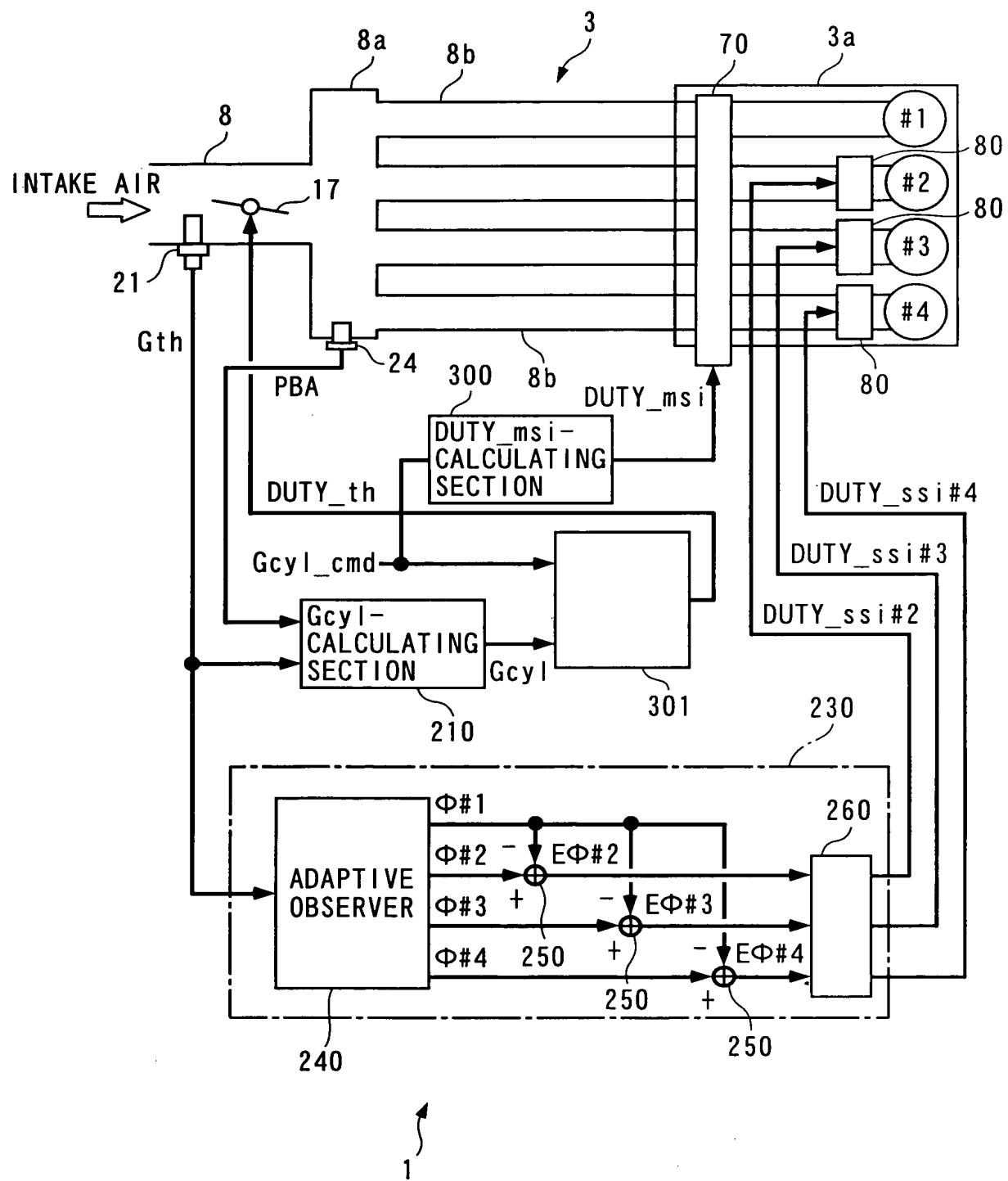


FIG. 67



F I G. 6 8



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